THE ENGINEERING RECORD
PUBLISHED WEEKLY BY THE
McGraw Publishing Company
MAIN OFFICES:
114 LIBERTY STREET, NEW YORK.
BRANCH OFFICES:
PHILADELPHIA: Real Estate Trust Bldg.
CHICAGO: 1140 Monadnock Block.
CLEVELAND: Cuyahoga Building.
LONDON OFFICE: Hastings House, Norfolk St., Strand.

SUBSCRIPTION RATES.

United States, Canada, Cuba and Mexico....$3.00 a year
Foreign subscription ....$6.00 a year
25 shillings. 25 marks. 31 francs.

Foreign subscriptions may be sent to our London office.

NOTICE TO ADVERTISERS.

Changes in advertisements intended for a particular issue should reach the office of THE ENGINEERING RECORD on Friday of the previous week. New advertisements can be received up to noon of Wednesday of the week of issue.

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Entered at the New York Post-Office as Second Class mail matter.

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Of this issue of THE ENGINEERING RECORD 14,000 copies are printed. Total circulation for 1907 to date 187,250 copies, an average of 14,404 copies per week.

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The Electrification of Steam Roads.

The problems of heavy electric traction and the electrification of existing steam railroads have been subjects for discussion at many recent meetings of various engineering organizations, and one who follows the reports of such discussions is struck by the wide divergence of opinion, not only as to the conditions of feasibility and economical practicability, but as to methods. This difference of opinion, while most marked as between electrical and steam railroad engineers, also exists to a great extent between engineers of the same class. This is a healthful condition. While the directions of thought and effort seem to be at every possible angle, the solution will be found as a resultant of the diagrams of intellectual forces, each according to its worth. We may be progressing in different directions, but if we are bound for the same goal and start from different locations we cannot arrive at the same point by moving in parallel lines. It must be remembered also that the goal may have different aspects from the different points of view, and to those who are in a position to see its rougher sides we should listen with especial care. In its finality, all sides will be visible and the sooner we understand what limitations, if any, there are, the better prepared we shall be for the task.

It is frequently claimed by steam railroad engineers that the electrical engineer is prone to drift into discussions of methods rather than of the conditions under which it will pay to discard the steam locomotive in favor of electric power. In making such a complaint, the fact that methods must be thrashed out and proved before the main question can be solved, is overlooked.

While discussions regarding voltages, frequencies, and such subjects may be extremely uninteresting to the steam railroad man, they are questions which must be solved satisfactorily before the main question which involves all of these details can be answered. Such matters the electrical engineer is wholly competent to decide. But in the application of his solution of these purely electrical questions to the operation of heavy traffic, he should not hesitate to listen to and weigh carefully expressions of opinion from steam railroad engineers whose experience has been long and costly.

Present electric railway practice has been a slow evolution through the horse-car days from omnibus transportation. The adoption and perfection of the use of electric power for the propulsion of street cars required radical changes from the methods of animal haulage. The high speed interurban road has again been a development from the city street-car service. These roads, being built and managed by former street-car men, were first patterned along the lines of the city railway, but as development progressed and higher speeds were demanded, the management of these roads found that it was not only advisable, but necessary, to follow steam railroad practice very closely in a number of directions. The attainment of this knowledge was very expensive in some cases, but the change has been made. These roads, as a result, are now being built, whenever possible, on a wide private right-of-way, with grade and track construction in almost every detail a duplication of good steam railroad practice, and the trains are being operated by a system of rules and signals and despatching as nearly as the conditions will allow like those adopted by the steam lines.

In the problem of heavy electric traction which is now coming there is surely great reason for electrical engineers to consider seriously whatever suggestions the steam railroad engineer may deem it worth while to make on the subject. The experience obtained in elevated, subway or interurban railroading can no more be applied entire to this larger problem than could street railway practice answer entire for interurban work. In modifying the practice to suit the different conditions, the man to whom these conditions are old should be a valuable co-worker. The conditions are old to him because he has grown up with them and they have developed with him. They may be even so familiar that he cannot imagine them associated with any other motive power than steam. Even when this is the case, and he seems obdurate in his efforts to prove that there is no good in electrification, his very zeal in attempting to show the new thing wrong in toto may suffice to point out some weak spot which may have been overlooked by the electrical engineer.

The locomotive builder who is sure that the electric locomotive should be of the same general design as the present steam locomotive may be right to a certain extent. It may not prove to be best, as has been suggested, simply to remove the furnace, boiler and engines from the present locomotive and substitute in the space so gained an electric motor designed to take up the same room in the same general shape. The general design of the steam locomotive is due to the requirements of steam boilers and engines for space in which to develop the required power, requirements by no means the same as those of the electric motor. It may not be best to transmit the power from the motor to the wheels through driving rods, but it may be found advantageous to connect the drivers by connecting rods. Out of his suggestions no good may come but this or some other "minor" feature, which may, however, be an important one. If some one detail in the finally accepted design is its only fruit, that man's suggestion, even though as a whole it is laughed at now, will have been valuable. The problem is one of such great proportions that it cannot be solved as a whole, but only by the combined strength of many minds approaching it from many directions, and while we are hearing and reading all sorts of ideas on the subject, we should take them patiently, with the knowledge that each one is playing its own part—some a large one and some a small one—in a very large game.

Economy in Combination Power Plants.

In the operation of a power plant producing electricity for a single class of service the character of the load at different hours of the day can usually be anticipated with a fair degree of accuracy. The magnitude of momentary variations in output cannot, as a rule, be predicted in their occurrence at any special time, but the broad sweep of the load curve from hour to hour can be forestalled if the output has been plotted previously for a wide range of known conditions. A fairly definite schedule can therefore be laid down as to the proper time to be ready to cut machines in or out of service, and the process may be carried back to the boiler room in almost every case. This fitting of boilers, engines and generators to the load so that as far as possible each unit shall operate at maximum economy constitutes the essential strategy of power house efficiency campaigns.

With the best of care it is very frequently impossible to continually load the individual machines economically in a plant devoted to one kind of work, unless the load varies evenly and without excessive fluctuations. It is no easy matter to select the proper sizes of generating units for efficient partial load operation in a new plant which has never been in commercial service. When the load peaks come on with the rapidity of the morning and afternoon rushes of the street railway system, with marked differences in the two peak outputs, it is likely to be a matter of compromise even to maintain the various equipment units in service at fractional outputs within the economical range. That is, the larger machines may be run with fairly close economy, leaving the smaller units to take care of the more frequent fluctuations at less efficient outputs per unit. On a violently shifting load the conditions cannot be expected to remain constant, and there must be a certain amount of reserve capacity held back in order to handle the traffic. In a turbine station which meets its owner's expectations in efficiency at light loads these irregularities of output are far less influential in increasing the normal fuel consumption.

Considerable difference in opinion exists as to the possible economy of combined railway, lighting and power plants. Some of the most creditable records of fuel consumption and labor cost have come from railway plants of three or four thousand kilowatts capacity. In some communities it is hard to match up the irregularities of the separate service curves so as to produce a fairly smooth curve of total output. The storage battery is a help in direct current systems, but there is no gainsaying the cost of its installation, its moderate efficiency of transformation and its maintenance expenses. Batteries are gradually being utilized in systems in which a large part of the output is alternating current, but at a definite charge for conversion. If all the conditions were known in comparing power costs, however, it is safe to say that intrinsically there is seldom the same economy in a single service of the fluctuating type that there is in the proper combination of services. If the overlapping of peak loads can be prevented, the chances of increasing efficiency by consolidating the output upon a single set of bus-bars make the experiment well worth trying. It is only within recent years that fluctuating power and lighting loads could be carried on the same machines without wretched results at the lamp filaments. The modern voltage regulation has solved this problem excellently.

In a combined plant of the average sort the railway load is nominal during the night; it rises to a sharp maximum at 7.30 or 8 a.m., holds fairly steady through the forenoon at a lower value, and in the late afternoon rises to the extreme value of the day, which is ordinarily reached between 5 and 6 o'clock. The evening traffic is a gradual sag from the moderate movement of 7 or 8 o'clock to the inconsequential load of the early morning hours. The lighting load of such a station should preferably include the all-night street illumination, which enables the combined units to operate at a fairly decent average output during the night. In the morning the lighting output sags off to nominal values, so that there is rarely any overlapping at the time of the morning railway peak. Through the day the lighting load is of little moment, in most cases, though if the company encourages the use of large single-phase motors—say from 5 h.p. upward—on the incandescent mains, the day load on the lighting circuits will sooner or later become quite appreciable. In the winter months the lighting peak and the railway maximum are likely to come close together, but this condition does not last many weeks as a rule; and if the equipment is put in first-class order before the end of the fall, it ought to be possible to pull through the worst demand, which is that of Christmas week in most cases. Through the greater part of the year the relatively large lighting output of the evening hours helps to offset the moderate railway load.

The influence of the power curve is less determinate for general practice, for the times of peak load do not follow the same cycle as the railway and lighting outputs. If 24-hour power is sold, the average load can generally be held at a fairly even maximum. Otherwise there is sure to be a pronounced peak at about 7 a.m., a drop of perhaps 50 per cent. at noon and a reasonably steady afternoon load until 5 or 6 o'clock. The power curve usually has the advantage of being relatively free from fluctuations of the severe kind if it has the disadvantage of varying widely in general sweep, according to local conditions and rates. The careful study of the three total loads in a combination power plant is less often attempted than is desirable for the best economy. In such plants the switchboard is usually provided with a single totalizing wattmeter and ammeter possibly, in the bus-bars between the generating and distributing sides of the plant. If enough instruments are installed to enable the hourly total variations in each class of service to be recorded and plotted, and if the hours in which the various employes, boilers, engines and generators are studied in connection with the loads, the data ought to furnish a basis of economical power production possible only in the most exceptional single service plants.

Passenger Terminal Problems in Boston.

The enormous sums of money expended on railroad development in large cities during the past five years emphasize the far-reaching importance of the passenger terminal problem to both the public and transportation interests. It is of great consequence when questions come up involving possible changes in terminal location that every phase of the situation be thoroughly analyzed, and that hasty conclusions based on insufficient data be avoided. A case in point is that of the Boston & Albany Railroad in reference to a proposed removal from the Boston South station to Park Square, on account of the increasing traffic at the present terminal. The New York, New Haven & Hartford Railroad and the New York Central as lessees of the Boston & Albany have jointly occupied the South Station in Boston since that terminal was opened for full service some seven years ago. Seven of the twenty-eight stub tracks in the trainshed are used by the Boston & Albany, but it is evident that the time is not far distant when measures will have to be taken to extend the facilities now available for handling its local and through traffic. About 835 trains now enter and leave the terminal daily, and in the busiest periods in morning and afternoon it is increasingly difficult to avoid delays in the vast network of interlocking tracks which serve the station. The proposal of the Boston & Albany management to rehabilitate the old Providence station property at Park Square has aroused a great deal of controversy, and this has not been lessened by the further suggestion on the part of the company that the location of its terminal half a mile farther west in the Exeter St. yards of the Back Bay district might be the best solution of the problem.

It is fortunate that a change of this kind cannot be made hastily, for until all the interests concerned have the opportunity to be heard before the proper legislative tribunal, a wise decision is difficult to reach. There is always a great deal of hysterical clamor in the press when a change involving large property values and broad public convenience is suggested, and before the engineering, legal, commercial and sociological points of view are brought forward by experts, it is hard to estimate the case from any other standpoint than that of personal opinion.

The burden of proof that a change in terminals is necessary, however, rests upon the railroad company; for the tendency of the age is toward the consolidation rather than the segregation of facilities. The convenience of union stations is indisputable, although in the case of a system of the magnitude of the Pennsylvania Railroad entering a city the size of New York, a separate terminal is pretty close to an absolute necessity. When a great terminal station has once been established, the business districts in its vicinity undergo a steady development, and thousands of persons adjust their daily life and their business convenience to the accessibility of the transportation service. It is a serious problem when the traffic outgrows the facilities offered, and in general only two plans of procedure are possible, extension underground or overhead at the original site, or removal to other neighborhoods. Consideration of these questions involves a study of the possibilities of electricity instead of steam as a terminal motive power, for without electrification it is impracticable to operate either subway or elevated trackage on the scale required in a large urban terminal handling tens of millions of passengers yearly. Central location involving accessibility to offices, shopping districts, banking houses and retail establishments, the use of business streets as thoroughfares, the increasing of distributing points with reference to the probable future growth of the city's mercantile activities, the relation of local transit lines to the terminal situation, and the comparative estimated cost of construction and operation of expansion and relocation schemes, must all be taken into account. The study of real estate values and taxation charges over a period of years, the investigation of deeds and titles, and the analysis of tributary territory by diagrams showing by intersections areas common to several schemes are essential points to be investigated before the sweeping changes which follow a terminal relocation can be set in motion.

In the Boston situation it has apparently not yet been shown that electrified suburban service at the South Station, with the use of the long-idle double track subway which was built beneath the building for the express purpose of handling local business on the loop scheme, would be unequal to the traffic demands for many years to come. Until the problem has been illuminated from all sides, public opinion should remain open to the influence of facts yet to be presented. Fundamentally, the location of a railroad terminal is a broad series of engineering problems which can never be properly solved by snap judgments. The interests at stake are too large to allow hasty generalizations to settle such wide questions of mutually related corporation policy and public welfare.

Impervious Concrete.

With a closer knowledge of the constitution of Portland cement concrete as well as with the finer grinding of the improved methods of cement manufacture, the attainment of impervious concrete for moderately high heads of water pressure has already been realized by some engineers. Every one is familiar with the experiments made in the past of submitting ordinary Portland cement concrete to water pressures no higher than 50 or 60 lb. per square inch, with resulting seepage so free as to preclude any idea of even approximate imperviousness. In fact, the pervious character of ordinary cement mortar and concrete as laid up even in first-class reservoir walls has been so often disclosed by actual experience that the great majority of engineers have practically abandoned the idea of being able to produce impervious concrete under any conditions, except possibly those of the laboratory experiment. Some recent experiences, however, indicate conclusively that the case for impervious concrete is not so bad as ordinarily supposed.

In practically all of the older concrete work, the mixture was comparatively "dry"; there were engineers who believed in, and used, relatively wet mixtures, but the prevailing practice precluded such highly wet mixtures as many engineers are now using with eminently satisfactory results. Any failure to introduce abundant water for the concrete mixture will surely result in interstitial spaces of more or less magnitude in various parts of the mass. In other words, the mixture must be wet enough and it must be stirred enough in place to cause all portions of the mass to flow into solid and continuous internal contact, and thus have no interstitial voids, if the concrete is to be sufficiently dense to approximate the impervious condition. Some of the most recent experiences in concrete building construction, where it has been imperative to secure density of mass to insure a smooth, continuous surface, have conclusively shown that the concrete must be wet enough to permit stirring with a rod to a depth of even 2 or 3 ft. or more for the best results in every respect. Any condition even approaching that permitting the old practice of ramming is grossly fatal to the greatest density or to imperviousness. Under conditions where it is necessary to flow the concrete around steel reinforcement of either rods or shapes, the latter frequently riveted, resort to what may be termed a thick liquid concrete can not be avoided, and thus the increased density and other excellent qualities of such concrete have been adventitiously established in actual work on the largest scale. The agitation of this semiliquid mass when poured in place is absolutely essential for the release of any entrained air which might permanently be held if the concrete were to take its initial set without motion enough to release the air. Such motion also aids the settling together to the best advantage of the various graded sizes of sand, gravel or broken stone. The result will evidently be a mass in which practically all void spaces of sensible magnitude will be eliminated.

The conditions thus attained will give considerable density, but not necessarily sufficient to reach impermeability for high pressures of water. If the final surface is made with much pressure by the finishing tool there will be a substantial increase in impermeability. If the mass of concrete could be put in place with great pressure under the conditions set forth above, experience seems to indicate that complete imperviousness against water pressures as high at least as 100 to 150 lb. per square inch could be attained. As it is usually impossible to submit fresh concrete to great pressure as it is put in place, it is necessary to resort to as much pressure as practicable in hand troweling a surface layer of dense mortar against which the water is subsequently to act. To enhance the effect of pressure or even to close the ordinary interstitial spaces of mortar or concrete, there are various patented materials now coming into successful use, which are frequently added to the water of the mixture. While doubtless some of these materials will not prove satisfactory, some of them have been shown by actual test to be effective. It is yet uncertain to what extent they may be employed, but works already successfully executed show that satisfactory impermeability under comparatively high pressures is undoubtedly attainable by their use.

The idea of a patented article for general application in engineering structures may perhaps at first sight fail to square altogether with the ethics of professional engineering practice, but if so necessary an end as water-tightness under high heads can be reliably obtained through the aid of the United States Patent Office, there would seem to be no valid objection to such a procedure. On the other hand it would not be at all surprising if ways and means of reaching the same end should be found independently of patented or secret processes.

It is somewhat singular that some experimental investigations for determining methods of reaching imperviousness in Portland cement concrete indicate more satisfactory results with thin than with thick walls of concrete. This, however, may be an indication only, needing confirmation before full acceptance. There seems to be no reason why the difficulty found by water in passing through homogeneous and dense concrete, should not increase as the thickness of the wall to be penetrated becomes greater. It would be surprising if with all the circumstances of the tests of this character known, a very thin wall of a large conduit under high pressure should give less leakage of water through it, than a thick one.

The admirable adaptability of concrete to conduit or aqueduct construction makes it eminently desirable to find some economical method of making it completely impermeable under pressures as high as 100 to 200 lb. per square inch, if not more. There have been known for many years more or less effective solutions for making mortar joints and other parts of reservoir or aqueduct masonry more or less water-tight, but such methods are crude and not altogether satisfactory, even for small pressures. More certain and substantial results are demanded, and those already outlined above are sufficiently encouraging to give reasonable ground for the belief that the demand can be met for fairly high pressures.

Notes and Comments.

Canadian Subscribers of The Engineering Record will probably be interested in a condition which arises on account of the expiration of the present postal treaty between the United States and Canada on May 7. The Canadian Government now has before it a proposition to increase the rate of postage on periodicals from the United States to such an extent as to render it necessary for American publishers to raise their subscription prices to Canadian subscribers from 50 to 100 per cent. If the Canadian friends of this journal object to such an increase, it will be well to make known their objections at once to the Dominion postal authorities. The Engineering Record has always felt that the subscribers it had among Canadian engineers and contractors were among its most valued business friends, for they have been frank with their criticisms and free with their praises in a most gratifying manner. They will readily see, it is hoped, that where postal requirements are made heavier than they are now it is a business impossibility to mail a journal like The Engineering Record at the present price, except at a heavy loss, and it will become necessary to increase its subscription price.

The Cameron Septic Tank Patent has passed through the first stage of its judicial appraisal and been found wanting in a decision by Judge Ray, of which an abstract appears elsewhere in this issue. This is the first time, it is understood, that any court has passed on the validity of the patent, and the decision is accordingly one of more than usual interest to sanitary engineers; the matter is not settled, however, as the Cameron Septic Tank Co. will probably appeal the case. This is a course that is highly desirable from all points of view, for until the numerous claims in the patent are reviewed by the court of final jurisdiction in such cases, important principles and apparatus used in sewage disposal will be regarded with suspicion by a good many municipal officers, as calculated to entail litigation. Attention should also be called to the fact that the thorough conduct of the case by the village of Saratoga Springs was largely due to the energy of Mr. John J. Healey, Jr., its lawyer, and Messrs. John W. Alvord and F. Herbert Snow, its consulting engineers, whose sacrifice of time and ability in order to bring this important subject to a conclusion deserves the thanks of the engineering profession. They labored under many disadvantages in this work, which they carried through largely from a sense of public duty.

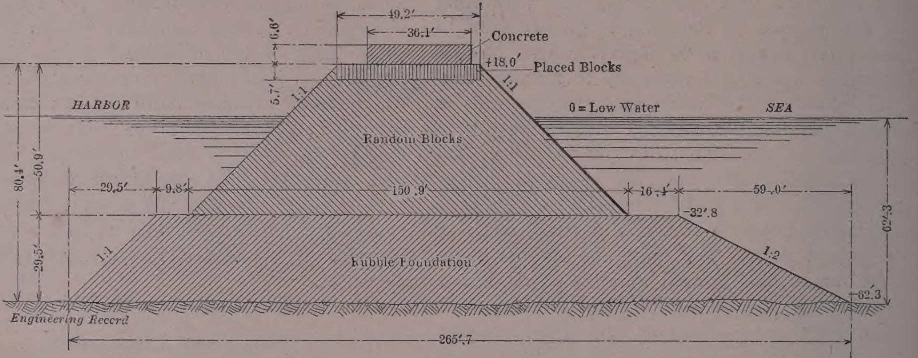
The Pittsburg Flood that took place lately again brings up the question of flood prevention and the importance of a study of the whole subject. The reports from Pittsburg regarding the amount of damage done in the last fortnight are very indefinite, but all agree that the property losses amount to at least a million dollars, while the losses to workmen through enforced idleness will reach a large total. It is probably safe to say that an expenditure of one-tenth this sum by a competent commission will put the State in possession of enough information to draw up a plan for remedying such troubles to a considerable extent. There will always be great floods of this nature, against which it is hardly possible to provide efficiently and completely. This is no reason, however, for failing to take such precautions as common sense and scientific research show to be desirable. The fact that earthquakes are sometimes very severe in Japan does not cause the authorities of that country to remain passive and ignorant in the face of the ever-present menace, but has led them to organize a permanent earthquake commission which is constantly striving to enlarge our knowledge of these phenomena and to increase the means of reducing their disastrous effects. The flood troubles which occur along the upper Ohio valley should lead to similar action. The enormous damages which must be charged to them every decade should alone be sufficient incentive for a thorough investigation of the subject. As matters now stand, a few men with hobbies do all the talking while whole communities have to pay the piper. Engineers who have had an opportunity to investigate the flood protection measures of France, Germany, Switzerland and Austria know that such troubles as visited Pittsburg lately have no reason for occurring other than neglect in this age of enlightenment.

Bids at Figures Below Cost are so troublesome that most contractors and engineers desire to avoid them, but occasionally some one will make such a bid and insist on its being accepted. What will generally happen in a case of this sort is well shown by work recently done at Norfolk, Va., on the coagulating basin and water mains at that city's pumping station. When the work was advertised the nature of it was investigated by local contractors who put in bids based on their knowledge of the conditions. A New York company, however, put in a bid considerably lower, and the contract was given to it, although it was predicted at the time that the company would lose heavily unless weather conditions were particularly favorable. The natural result followed; the contracting company is now endeavoring to secure from the city a payment of at least a part of the losses which it has incurred through taking the work at a figure which was too low. Up to the present time there seems to be a feeling on the part of the city that there is no reason for paying these extra charges except one, due to excessive rainfall during July and August, which made the work so unexpectedly expensive that a part of this unusual expense might well be borne by the city. This case is a typical one and it is to be hoped that when the final decision is reached it will be in a spirit of fairness to the local contractors who did not get the work as well as to the city. Wide competition on public works is very desirable, but when that competition brings with it an element of unwarranted low bidding the advantages of such competition are somewhat reduced. The matter is always in the hands of local officials, for if they invariably insist on the contract being carried in its original spirit then troubles such as the one mentioned above will be avoided after the rod of discipline has been wielded vigorously once. If contract terms are not made obligatory on the contractors, then the local parties whose better knowledge prevented their making the low bids have reason to complain that they have been treated unfairly.

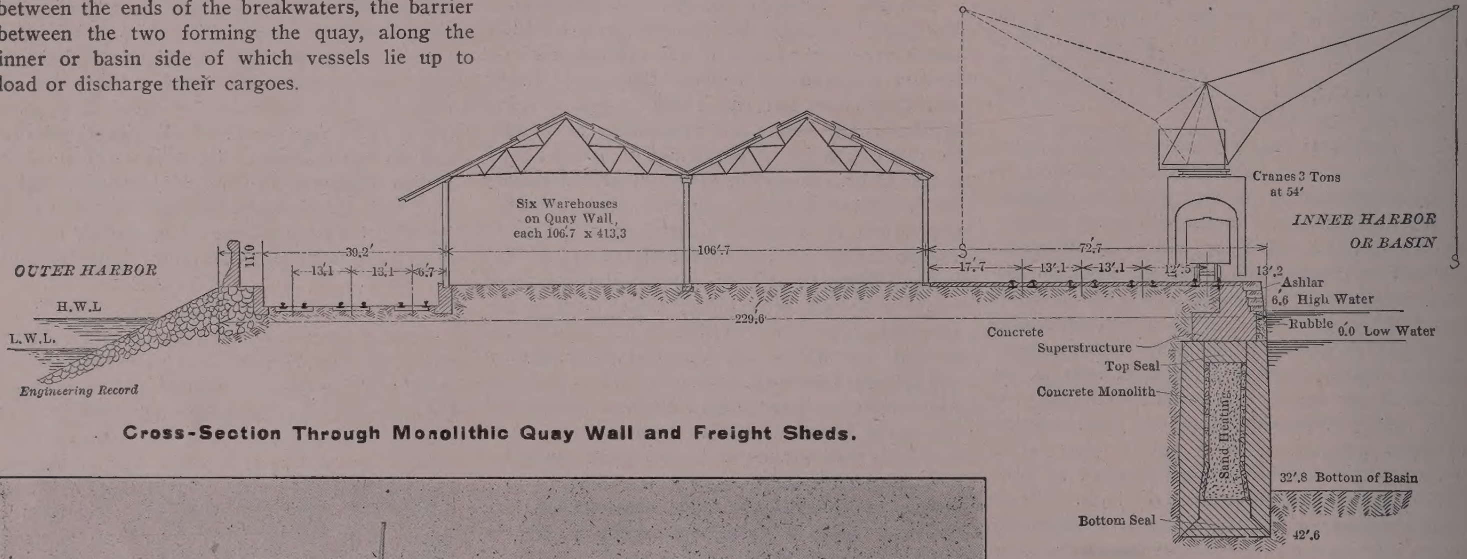
THE HARBOR IMPROVEMENTS AT SALINA CRUZ, MEXICO.

Notes on the Terminal Facilities at the Pacific Terminus of the Tehuantepec National Railroad.

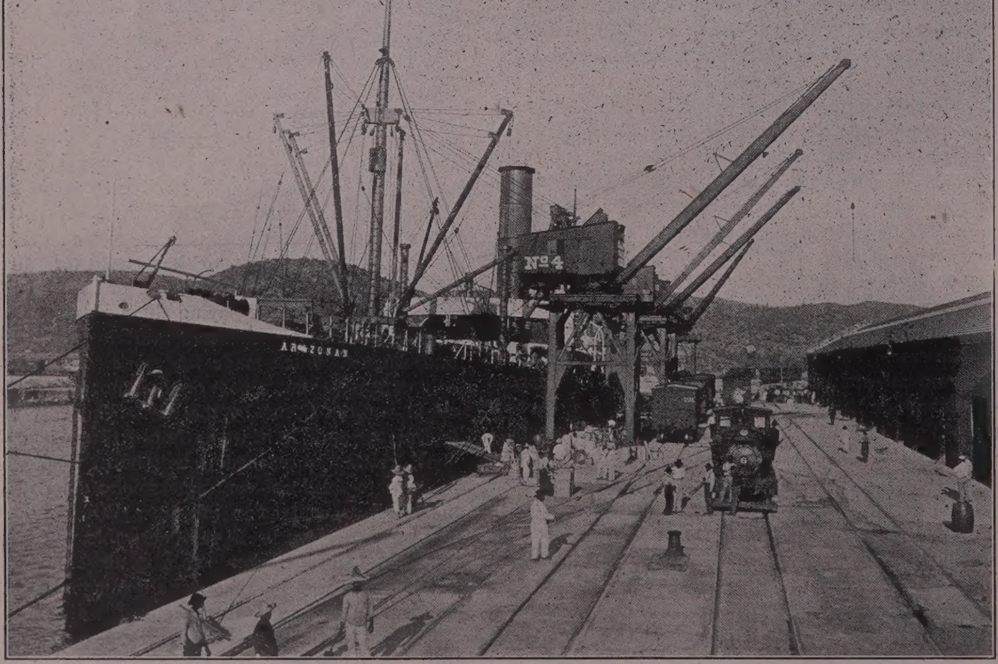
Salina Cruz has been called into existence as a modern commercial port by becoming the southern or Pacific terminus of the Tehuantepec National Railroad. The site chosen for the harbor is a bay open to the south, surrounded by a low chain of hills terminating in bold rocky headlands on the east and west sides. The outer harbor of the new port has been kept close in under the shelter of the west headland which, in fact, forms a base for one of the enclosing breakwaters. The other, or east breakwater, starting from a point on the beach, runs out directly seaward, making a sweep round to meet the west arm, the area enclosed being 130 acres, of which 96 acres have a depth of over 33 ft. The accompanying plan shows the general arrangement. It will be seen that the new harbor consists essentially of two portions, the outer bay already mentioned, and the inner harbor, or dock, lying within the general line of the coast between the ends of the breakwaters, the barrier between the two forming the quay, along the inner or basin side of which vessels lie up to load or discharge their cargoes.



Maximum Cross-Section of Breakwaters.



Cross-Section Through Monolithic Quay Wall and Freight Sheds.



General View of the Quay Wall Looking Eastward.

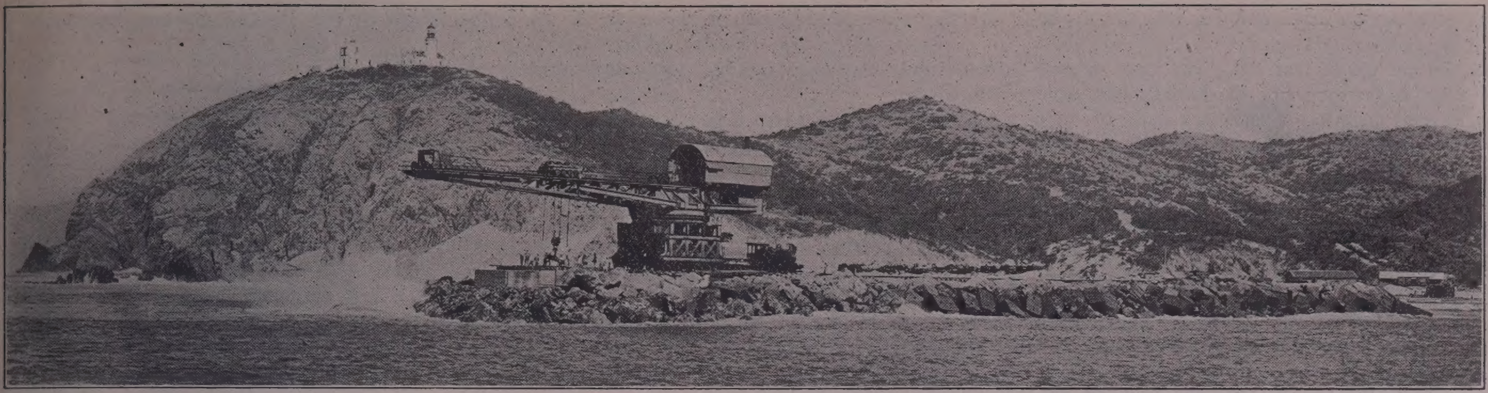
The accompanying cross-section of the breakwaters is taken at their maximum suction at the sea end, but the normal section is similar, only with a width of 33 ft. on top, the side and bottom slopes being the same. The bottom portion or foundation is rubble roughly level on top, with side slopes of 2:1 and 1:1 on the sea and harbor sides respectively; on top of it is the main body of random rubble blocks of natural rock and concrete, with side slopes of 1:1 on both sides. These blocks had to weigh at least 20 tons; the heaviest put in weighed 65 tons.

To make the breakwater solid the interstices between the blocks, about 30 per cent. of the whole, were filled up with rubble. The top of the main body is brought to a level with 40-ton concrete blocks laid side by side. The superstructure is a monolithic mass of concrete 20 ft. by 6 ft. 6 in., extending the whole length of the breakwaters, widening out at the sea ends to 36 ft., the top level being 18 ft. above high water.

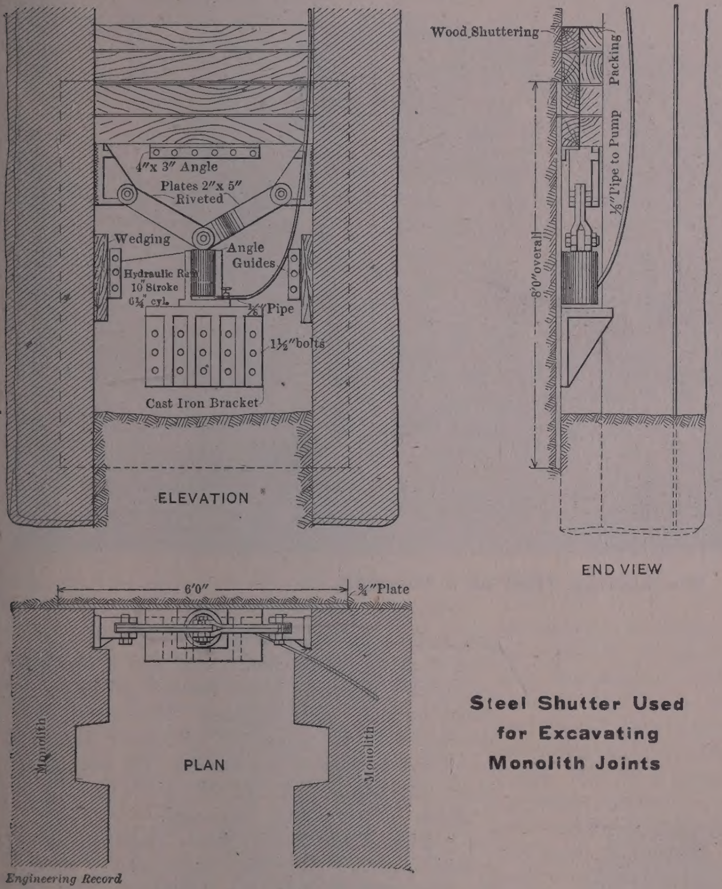
The east breakwater is 3,240 ft. long, the west 2,164 ft., or a total length of 5,404 ft. They contain between them 740,000 cubic meters of rubble and 234,000 cubic meters of blocks.

Each breakwater was built out from the shore line by Titan cranes capable of swinging a load of 36 tons at 75 ft. radius. The maximum tonnage handled by one crane in a shift of eight hours has mounted as high as 1,540 tons.

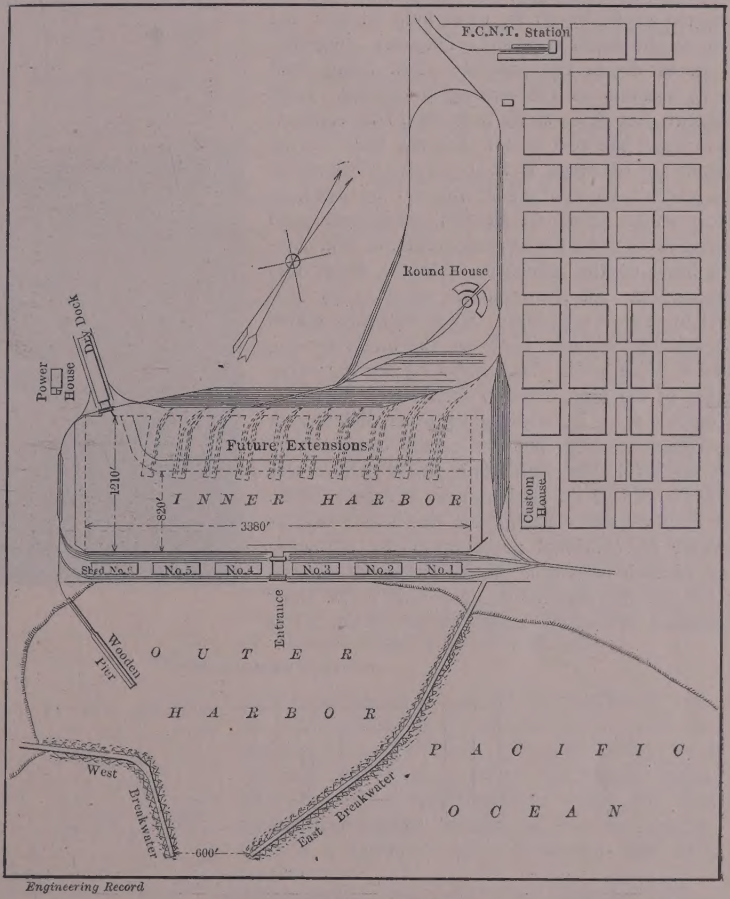
The rock used was taken from a quarry opened up for the purpose 20 miles off, on a branch line from the Tehuantepec Railroad. It is of a limestone formation, extremely hard and weighing 170 lb. per cubic foot. Large blocks were loaded on small special flat cars and the ordinary rubble in steel skips 8 ft. 6 in. by 14 ft. 6 in. by 2 ft. deep, placed mouth to mouth in ordinary flat cars. The advantage in unloading rubble loaded in this manner in a work of such magnitude paid the initial extra cost of the skips many times over. The concrete blocks weigh from 24 to 40 tons each and were made in a blockyard specially laid out and arranged for the purpose. The molds were set up on a concrete floor; over these, on a staging just high enough to clear the molds, ran an electric mixer. At the end of the yard, the mixer ran in underneath a platform where were the hoppers made to contain the requisite quantity of crushed rock, sand, cement and water, the crushed rock and sand being run up on a trestle incline to the level of the charging platform as required. The mixers were of the four-splay-sided steel shell type, revolving on a center axle and mounted on a traveling platform. The molding platform was 500 ft. long by 65 ft. wide, with room for three lines of molds, or 150 blocks and a car track. A Goliath crane spanned the yard, for



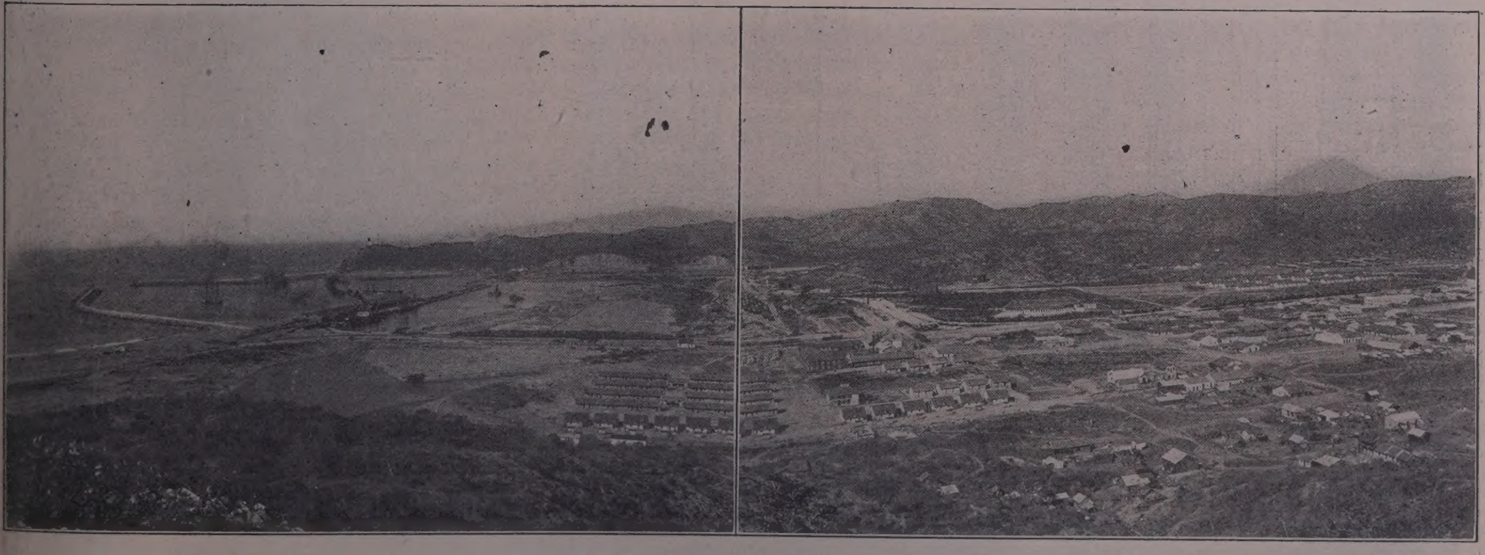
Titan Crane in Use During the Construction of the West Breakwater.



Steel Shutter Used for Excavating Monolith Joints



Map of Salina Cruz Post Works.

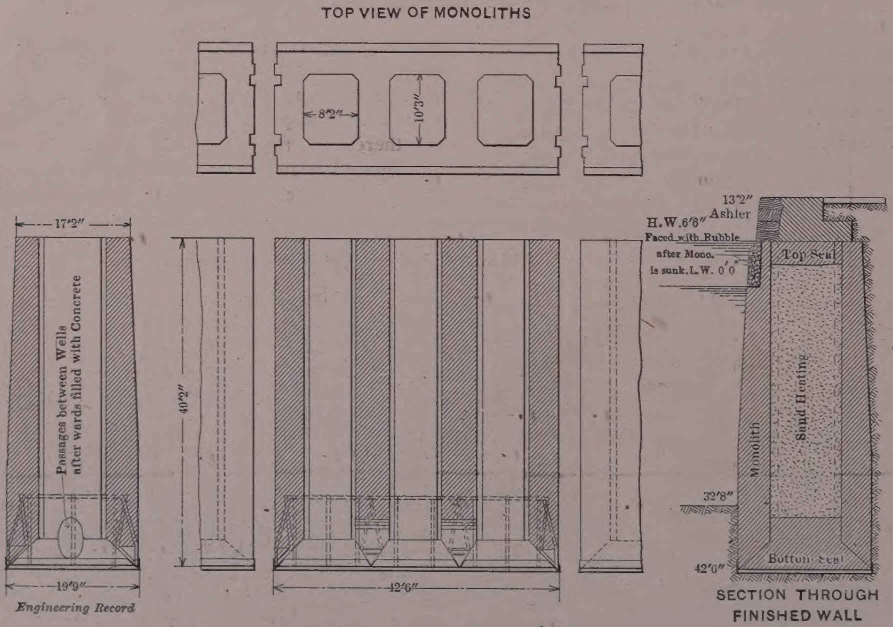


General View of the Harbor Works of Salina Cruz, Looking Toward the West.

stacking and loading; the stacking ground occupies an area at each end of 43,000 sq. ft.

The entrance from the outer to the inner basin is 100 ft. wide. The rise and fall of the tide being only 6 ft., no lock gates are necessary; and the minimum depth of water inside the basin at low tide being 33 ft., vessels drawing up to this depth can get in and out of dock at any state of the tide. The inner basin has an area of about 50 acres and requires the dredging by suction and bucket dredges of about 4,000,000 cu. yd. of material. The quay extends for 1,640 ft. on each side of the entrance, making a total length of berthing space of 3,280 ft.; its cross-section is shown in an accompanying illustration. As additional space is required, piers will be built from the north side, sufficient ground being retained here in reserve for this purpose.

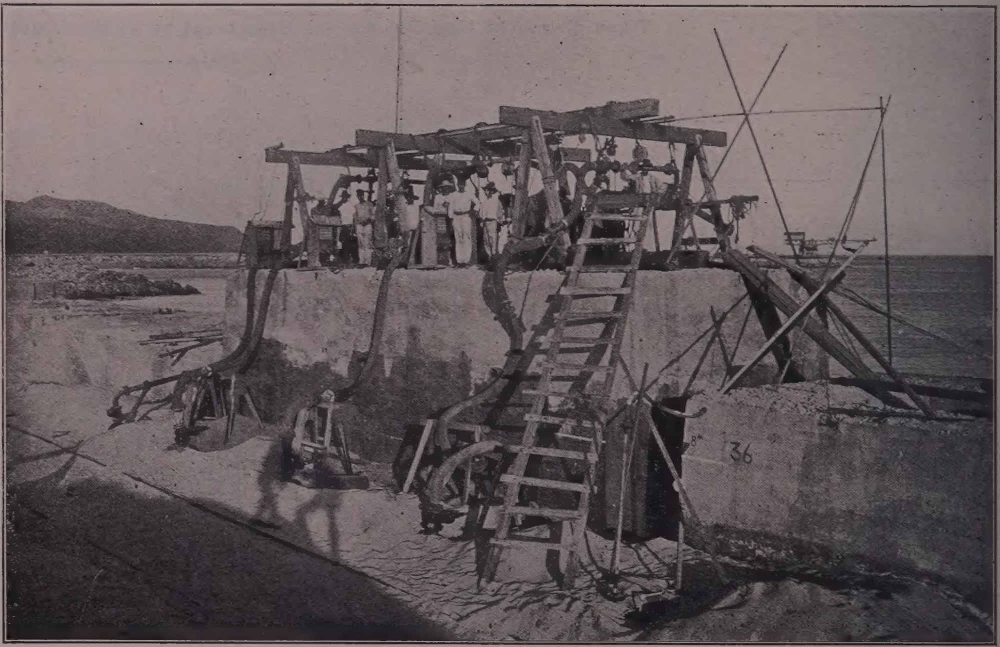
The construction of the quay wall from an engineering point of view, was the most interesting part of the work. Located along the line of the original high-water mark and in the earlier stages of the work getting little or no protection from the breakwaters, the situation precluded open trenches of any description. To overcome the difficulty, immense monoliths of concrete 42 ft. by 20 ft. were built in situ and sunk to the depth required. They are altogether 50 ft. in depth, the concrete work being built up in sections as the sinking proceeded. Each monolith has three wells 8 ft. by 10 ft. connected through the two center dividing walls at the bottom by openings 6 ft. by 4 ft. Excavation was carried on in these in the dry by hand, to below water level. Grabs and centrifugal sand pumps carried on the sinking until the skin friction hung up the monolith, when the water was pumped out and the monolith sunk to its final level by hand excavation. Each well was sealed top and bottom with concrete, the interior being filled in with sand. The timbering for the excavation of the joint between each monolith, which is only 3 ft. 3 in. wide, gave some difficulty at the commencement, but was finally overcome by the use of a flat iron plate shield which was driven ahead of the timbering by hydraulic jacks, the head of water being kept down as much as possible by continual pumping in the adjoining well of each monolith. These spaces being concreted up, this formed a solid wall 20 ft. thick extending the whole length of the basin. It is faced with rubble between high and low water and has a concrete superstructure built in situ, faced with ashlar and capped with granite, and is altogether a solid and substantial piece of work.



Sections of Monolith and Shoe, Quay Wall.

At the northwest corner of the basin, a dry dock has been built. It has a total length of 624 ft., which can be increased with the caisson gate in the outer recess to 675 ft. The depth over the sill is 36 ft. 6 in. and the width between cope of 100 ft. It can be emptied in four hours by centrifugal pumps, of which there are two sets twin-coupled, driven by motors attached directly to the center shaft, with suctions 40 in. in diameter and a 22-in. diameter discharge from each pump. A 9-in. centrifugal pump deals with the leakage.

As the success of a port depends largely on the rapid and careful handling of cargo, special attention has been paid to this point. The cargo is handled by electric cranes, while the cars can be shunted into position through cross-over tracks, or carried over by transfer tables and hauled into position by electric capstans. On the quays are six freight sheds, each with a floor area of 44,100 sq. ft., while over 25 miles of track have been laid down in yards and sidings for the mustering of cars.



The Sinking Plant on a Monolith.

The yards and quays are lit up by numerous powerful arc lights enabling work to go on by night as well as by day.

The cost of the undertaking has totalled to date $20,000,000, gold, the work having been carried out by the contractors, Messrs. S. Pearson & Son, Ltd., of New York and London; Mr. J. B. Body being the resident director in Mexico, and Mr. R. Adam, M. Am. Soc. C. E., the engineer, with Mr. F. Adams, M. Am. Soc. C. E., in direct charge of the work.

The Work of the United States Reclamation Service.

The United States Reclamation Service on Jan. 1 had completed 1,267 miles of canals, or nearly the distance from Washington to Omaha. Some of these canals carry whole rivers, like the Truckee, in Nevada, and the North Platte, in Wyoming. The tunnels excavated are 47 in number, and have an aggregate length of 9½ miles. The Service has erected 94 large structures, including the great dams in Nevada and the Minidoka dam in Idaho 80 ft. high and 650 ft. long. It has completed 670 headworks, flumes, and such works, and has built 376 miles of wagon road in mountainous country and into heretofore inaccessible regions. It has erected and in operation 727 miles of telephones. Its cement mill has manufactured 70,000 bbl. of cement, and the purchased amount is 312,000 bbl. Its saw mills have cut 3,036,000 ft. B. M. of lumber, and 6,540,000 ft. have been purchased. The surveying parties of the Service have completed topographic surveys covering 10,970 square miles, an area greater than the combined areas of Massachusetts and Rhode Island. The transit lines had a length of 18,900 linear miles, while the level lines run amount to 24,218 miles, or nearly sufficient to go around the earth. The diamond drillings for dam sites and canals amount to 47,515 ft., or more than 9 miles. Today the Service owns and has at work 1,154 horses and mules. It operates 9 locomotives, 223 cars and 23 miles of railroad, 39 stationary engines and 27 steam engines. It has constructed and is operating five electric light plants. This work has been carried on with the following force: Classified service, 380, including Washington office; laborers employed directly by the Government, 3,500; laborers employed by contractors, 6,100, or a total of all forces of 10,000. The expenditures now total nearly $1,000,000 per month. As a result of the operations of the Reclamation Service eight new towns have been established, 100 miles of branch railroads have been constructed, and 10,000 people have taken up their residence in the desert.

The Indiana Union Traction Co. has inaugurated an express service on all its lines. The rates will be lower than those charged by the express companies operating on steam roads. All except limited cars will carry express.

A Decision on the Cameron Patent for Process of and Apparatus for Treating Sewage.

On March 12 Judge Ray, of the U. S. Circuit Court for the Northern District of New York, filed his opinion in the suit in equity brought by the Cameron Septic Tank Co. against the village of Saratoga Springs and the Sewer, Water and Street Commission of that place, to restrain an alleged infringement of U. S. patent 634,423, granted on Oct. 3, 1899, to Messrs. Donald Cameron, Frederick J. Commin and Arthur J. Martin, of Exeter, England. This patent is the same as British patent 21,142, dated Nov. 8, 1895. It declares that the invention consists, 1, in certain methods of developing, in a flowing current of sewage, bacteria capable of dissolving the mass of solid organic matter contained in the sewage; 2, of subsequently utilizing the so-developed bacteria in liquefying the mass of organic matter contained in the flowing current of sewage; and, 3, of further purifying the effluent liquid. The patent then declares that the invention also consists in the apparatus for carrying out the process. It further declares that "the process of purification comprises the subjection of the sewage to the dissolving action of anaerobic bacteria and subsequently to exposure to air and light."

The Patented Process.—The patent describes the process as follows: "In carrying out the process the first step is to develop in a flowing current of sewage micro-organisms or bacteria of a character and quantity capable of practically liquefying the mass of solid organic matter contained in the flowing current of sewage. This is effected by forming a pool in the flowing current and secluding said pool from light, air and agitation, while permitting a non-disturbing inflow of the sewage into the pool and an outflow therefrom. In this condition of the pool in the absence of light, air and agitation, the micro-organisms increase at a fabulous rate, being fed by the incoming solid matter of the sewage until a mass of bacteria is developed sufficient in character and quantity to liquefy substantially all the solid organic matter contained in the sewage passing through the pool. During this operation there is formed on the surface of the sewage in the pool a brown scum. This crust of solid substances floating and completely bridging over the water is from 2 to 3 in. thick, and although there is a continued inflow of raw sewage and a continued outflow of the liquid effluent, this scum remains at about the same thickness and does not increase. This scum attains its thickness of from 2 to 3 in. in about a week after the tank is put into use, and although no part of it is removed it continues at the same thickness. After the formation of this practical solid-dissolving mass of bacteria, the non-disturbing inflow and outflow are continued until practically all the solid organic matter is dissolved and the outflow is in the form of a liquid without solid particles of sewage. The operation goes on and the flowing current of sewage is continually liquefied. The liquefied sewage as it leaves the septic pool has a slight odor, so slight, however, that it cannot be noticed at a distance of a yard or two, and to relieve it of this slight odor it is subjected to an aerating operation."

The claims for this process read as follows:

"1. The process of purifying sewage which consists in subjecting the sewage under exclusion of air, of light and of agitation to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied, and then subjecting the liquid effluent to air and light.

2. The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under exclusion of light and air and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved.

3. The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, and then subjecting the liquid overflow to an aerating operation.

4. The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, then subjecting the liquid outflow to an aerating operation, and then to a filtering operation.

21. The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a thick scum is formed on the surface thereof and a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under the cover of said scum and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved."

The completed purification, Judge Ray decides, consists, therefore, of three successive processes: 1, liquefication by anerobic action in the tank; 2, aeration in the aerator after leaving the tank; and, 3, filtration after leaving the aerator. This is a mere aggregation of processes, two of which are old, while the other is a process of nature or a natural process performed by nature on a pool of sewage held in a tank under proper conditions long enough for nature to do its work.

The Patented Apparatus.—The patent contains the following claims for the "apparatus":

"5. In an apparatus for the purification of sewage, the combination of a septic tank having an outlet disposed above the bottom and below the normal water-level of the tank, and open across the greater part of the width thereof, and an aerator connected with said outlet.

6. In an apparatus for purifying sewage, the combination of a drain or sewer, a settling tank, connected therewith and adapted to receive the contents thereof, a septic tank connected with said settling tank and provided with an outlet disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof.

7. In an apparatus for the purification of sewage, the combination of a septic tank, and an outlet therefor disposed above the bottom and below the normal water level thereof, said outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank.

8. In an apparatus for the purification of sewage, the combination of a septic tank having an outlet consisting of a pipe extending across the greater part of the width of the tank and disposed above the bottom and below the normal water level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent.

* * * * * * * * *

11. In an apparatus for purifying sewage, the combination of a septic tank, an inlet disposed above the bottom of the tank and below the normal water level thereof and occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water level thereof.

12. In an apparatus for purifying sewage, the combination of a septic tank, an inlet occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water level thereof, said outlet comprising a pipe having a longitudinal slot therein extending the greater part of its length.

* * * * * * * * *

20. In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water level thereof and provided with a broadened mouth, a non-disturbing outlet for said tank disposed below the normal water level thereof and provided with a broadened mouth, and a sewage conduit connected with said inlet.

* * * * * * * * *

22. In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water level thereof, a non-disturbing outlet for said tank disposed below the normal water level thereof, and a sewage conduit connected with said inlet."

Some of these means, in combination, if new and operative, would seem to disclose patentable invention, in Judge Ray's opinion. Such a tank as is described in its mere construction and shape and size, whether covered or not, is not new or novel. It neither performs any new or novel function nor permits or causes any new or novel function to be performed within it. As a closed tank, pure and simple, it holds the sewage placed therein by force of gravity or otherwise, and being darkened and made (in the beginning of the process) air tight it permits and enables one of the processes of nature to go on therein. Such always has been and such always will be the function of such a tank. The tank is to hold or contain the pool or mass of sewage; the outlet is for the escape of the fluid after nature has done its work; and the aerator is to expose the fluid after escape from the tank to the action of the air. The outlet is necessarily a part of the tank if it be made operative, an aperture or apertures or opening or openings into it. It permits the outflow of the fluids when they have so accumulated in the tank that the laws of nature force them out. But it must be so arranged as to be "non-disturbing." This seems to be done by its location below the surface of the sewage and by the width of the discharging opening or mouth. The aerator is attached or connected therewith, but not in any new or novel manner, and it performs no new or novel function. It has nothing watever to do with what is going on inside the tank. Its operation is a distinct one and the only connection it has with the one done in the tank is that it is performed on the same fluid produced in and which has come from the tank.

Judge Ray cannot see anything new or novel in the combination of claim 5 unless it resides in the "septic tank." In his opinion all tanks and receptacles, which permit the ingress and egress of flowing material and the formation of a pool of such material therein and the retention of such pool secluded from light and air and agitation until the anaerobic bacteria have sufficiently developed to convert the solids into fluids, are septic tanks in the sense of the patent. Hence the "septic tank" of the patent to be different from any other water, air and light tight tank must have joined with it openings and connections, which permit the reception, retention and repose of such material under the conditions named until the bacteriological action has taken place and been completed and then permit the outflow of the resultant fluid. As so construed claim 5 is held to be invalid as it does not disclose patentable invention. If the claim is valid every tank having an outlet disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof is monopolized if an aerator is connected to such outlet. As such tanks with such outlets were old in this art and the aerator, also old, has nothing to do with its operation, but simply receives the fluid for the purpose of aerating it by an operation or process of its own, Judge Ray does not see patentable invention in the combination.

Claims 6, 7, 8, 11 and 12 are held to be void for the same reason. The settling tank of claim 6 is entirely outside of the main tank, is old in the art and performs no new office or function, and has nothing whatever to do with the processes of liquefaction, aeration or filtration.

In claims 20 and 22 there is in combination, 1, a septic tank, 2, means for excluding air and light, 3, a non-disturbing inlet for said tank, 4, a non-disturbing outlet for said tank . . . and 5, a sewage conduit connected with said inlet. Here we have an operative and useful apparatus provided with a "non-disturbing" inlet and a non-disturbing outlet, and unless these are found in the prior art the claims may be valid.

The "non-disturbing inlet and outlet" are described in the specifications as follows:

"The inlet 63 to the tank discharges into same some distance below the normal water level and is preferably directed horizontally, or downward, as shown, so as to avoid breaking the scum which forms in the tank when sewage has been in it for two or three days."

"The outlet from the tank is submerged, preferably in the upper half of the depth of the tank, and is extended across the whole or the greater part of the width of the tank, so as to draw off the clear water below the scum or floating matter without disturbing the latter. It is necessary to discharge the contents of the tank or vessel along an extended line lest the flow should be concentrated to a point or points of discharge and so disturb and carry away the floating matter."

"The outlet therefore consists of a pipe or conduit 10, which may or may not be closed at its top, following the line along which it is desired that the contents of the vessel or tank A should be discharged, and having throughout its length or a part thereof a slot or aperture by which liquid may enter the said pipe or conduit. Such slots or apertures may diminish in size toward the outlet or outlets from the said pipe or conduit, so as to avoid an excessive rate of flow thereinto near such outlet or outlets, thus maintaining a uniform flow into such pipe or conduit throughout its length. The slots or apertures may be placed in any position along said pipe or conduit 10, so as to admit liquid into the same in a downward, upward, horizontal, or oblique direction, as may be desired."

The patent also says these slots or apertures in the pipe or conduit described may be protected to ward off solids or liquids coming from any particular direction or provided with a strainer for the exclusion of solid matter. Such devices are old in this art, Judge Ray decides.

Prior Art.—In discussing the prior art, Judge Ray refers first to the French patent No. 144,904 of Mouras, dated Sept. 22, 1881, which has a tank, connected sewer pipe, and outlet drawing off the liquid above the bottom of the tank and below its normal water level. This apparatus, it is stated by Judge Ray, apparently permits greater disturbance of the contents of the tank at both the inlet and outlet, than the apparatus in suit, and "evidently Mouras had no conception of the utility of or necessity for non-agitation of the contents of the tank." The tank devised by the late E. S. Philbrick and first described in this journal in May, 1881, is next referred to, and then the English patent of Lake, No, 5,391, June, 1882, and the American patent of F. L. Union, No. 424,838, April 1, 1890. In the English patent of Thomas Walker, No. 2,329, September, 1864, there is plainly pointed out and suggested, in Judge Ray's opinion, every idea of means contained in either the "non-disturbing inlet" or the "non-disturbing outlet" of the patent in suit. Other patents considered to indicate the same ideas are that of Wigner, a British patent of 1870, No. 364, and that of Meyer, an American patent of Sept. 19, 1893, No. 505,166. In the Scott-Moncrieff American patent No. 530,622, Dec. 11, 1894, and the Gurtler British patent, No. 7,134 of 1887, there is also evidence of apparatus to prevent the disturbance of the contents of tanks by special inlets, or outlets, or both.

Hence in the claims of compainant's patent in suit for apparatus Judge Ray fails to find patentable invention in view of the prior art. There is no improvement in apparatus, he says, that would not occur to any mechanic skilled in the art. In fact the only improvement, if it be that, is in the addition to the outlet of the "pipe having a longitudinal slot therein extending the greater part of its length." This is a mere substitute device to aid in the even and non-disturbing escape of the outflowing liquid. It is a slotted pipe to take water slowly and evenly and even if new shows no conception or idea of means amounting to invention. All the claims in suit for apparatus are invalid for want of invention in view of the prior art. But even if valid they must be given a very narrow construction and limited to the very devices specified, as for instance "a pipe having a longitudinal slot therein extending the greater part of its length."

Cameron seems to have described extended discovery as to the actual action of micro-organisms and anaerobic bacteria. Mouras discovered the result of their action in sewage about 40 years ago, some 20 years prior to his French patent. In December, 1881, an article on the subject and regarding the Mouras patent was published by M. F. Moigno in "Weekly Review of Science and Industry." This was followed by another article in the same journal written by Moigno, published in January, 1882. These articles describe the Mouras discovery and add discoveries and conclusions of their author, in which, after stating that he has seen and conversed with M. Mouras, among other things he says: "To-day at last, all obstacles being removed, I can freely expose in all its details, the simplest, finest, greatest perhaps, of the inventions of modern times. . . . The automatic scavenger is in fact: 1st, hermetically closed, and closed by the most inviolable of fastenings, hydraulic fastening, that is to say, its contents are shut off from all contact with the surrounding atmosphere; for that very reason, 2d, it is absolutely odorless and renders all infection impossible"; (Note these are results, but not the main purpose or necessity of making it air-tight.) "3rd, by a mysterious operation and one which reveals a quite new principle, it transforms all it receives, solid and liquid excrements, in a rather short space of time and without the addition of chemical ingredients, into a homogeneous liquid, only slightly turbid, and holding everything in suspension in the form of scarcely visible filaments, without leaving any deposit on the sides of the evacuation pipe nor at the bottom of the drain pipe. . . . 5th, the liquid which escapes, while it contains all the organic and inorganic elements of the evacuations is almost odorless. . . . Are not these results truly marvelous, which leave absolutely nothing to be desired, which moreover go beyond all hopes and expectations."

He also points out that there is no sludge or refuse, nothing left to take from the tank and also the necessity of having the inlet and outlet below the surface of the sewage. In short the "sludge problem" is solved and the process of nature published to the world.

In his article of Jan. 21, 1882, Moigno points out certain results and advantages, and then says:

"That is already marvelous, but what is still more marvelous is the fact that these great results are very nearly effects which cause or are produced almost from nothing by the simple material transformation of the ordinary barbarous cesspool, without appeal to any new agent, without the invention of chemical ingredients, or even without addition of water from other sources, by the sole fact that the transformed tank lends itself to the employment, or better, to the bringing into play of a force of nature wholly unforeseen and unknown till the present time, mysterious as well as marvelous in its magic effects. Who would have suspected that animal evacuations naturally contain and carry with them the principle of fermentation or of dissolution necessary and sufficient to liquefy and render them immediately of use in their return to the soil which had furnished their element, not without impoverishing itself? . . . Air-tightness, impenetrability to liquids or air is the essential condition of the successful working of the scavenger; it becomes, also, before everything, odorless. . . .

Thus filled with water and hermetically closed, the scavenger is ready to fulfil its functions truly marvelous and extremely effective. If a first litre of feces enters the tank, there will come out of it a litre of water which will be nothing but pure water; but after a certain time of operation, when the feces shall have entered in sufficient quantity the liquid discharge will begin to be turbid and of a brownish color, not very dark. But however prolonged the workings of the scavenger may be, were they to last twenty years, however great the quantity of feces that may enter its bowels, on the sole condition that there shall have been allowed to penetrate at the same time the urine and in a certain proportion slops and rain water, there will never come out anything but the slightly turbid colored liquid which is the only discharge from the hermetically closed tank. Why? Because there is going on in the heart of the scavenger a process of fermentation entirely unforeseen, which dissolved in a more or less brief space of time the most solid feces and divides foreign bodies into porticules or fibres so thin that they can scarcely be seen floating in the turbid liquid, without the latter forming any deposit, or at least any deposit that adheres to the sides of the vessels or pipe through which it flows."

He then goes to the reasons for this action, the causes, and says:

"3rd. Theory of secret of the scavenger. Here comes up the great question: How are solid matters so unassailable by water, so insoluble in water, by the contact with water, dissolved and made liquid so surely and easily in the heart of the automatic scavenger? I do not yet know in a certain and rational way. . . .

"Therefore, if I am not mistaken, in the heart of the scavenger, the great agent of dissolution, of liquefaction would be hydrosulphate of ammonia or one of its congeners. Sheltered from contact with the air or oxygen its action would determine a kind of putrid fermentation the last period of which would be the dissolution, the liquefaction of the solid feces. . . . May it not be discovered perhaps that the mysterious agents of fermentation, cause of the decomposition and liquefaction of the feces are the vibrious or anaerobic bacteria which, according to Pasteur, are destroyed by oxygen and which manifest their destructive activity only in vessels from which the air is excluded?"

He then gives certain observations and experiments, and says, among other things:

"1st. Only urine, feces and a very little water, hardly a glass a day, entered the aquarium; nevertheless the liquefaction was complete; the excrements are so dissolved that they no longer sink to the bottom and everything remains in suspension in the liquid. Solid feces introduced the 29th of August were completely liquefied the 16th of September, with the exception of matter not digested by the stomach, stones and skins of grapes, the stony concretions of pears, etc. Onion and carrot peelings, cabbage leaves, etc., floated on the surface some time, then sank to the bottom to await their decomposition or dissolution; such is the case with all foreign substances that are soluble, and even with paper, which at first rises to the surface, becomes more and more saturated with water, sinks to the bottom and disappears, as if melted away. . . . The feces always rose to the surface, mixed together, forming a kind of slimy pulp, of a thickness which never exceeded five centimetres, in consequence of the constant dissolution of the lower layers. After there had been added ten litres of water, the undigested substances, such as vegetable refuse, were seen to arrange themselves on the surface, in the order of their density, then sink to the bottom of the tank to await their decomposition, which took place insensibly; it is a deposit, not sedimentary but flaky, which little by little melts and dissolves to be soon discharged by the waters of the aquarium, which show to the glance no foreign substance in suspension."

He also points out that absence of air is absolutely essential, as follows:

"Hermetical is therefore the condition necessary, indispensable and sufficient of the dissolution, of the liquefaction of the feces and of the wonderful working of the scavenger."

He has also discovered the "scum," for he says:

"The disaggregation or dilution of matter is complete after thirty days immersion in the tank, so that the feces never form on the surface of the water anything but a layer of 75 millimetres thickness, which renders their decomposition very easy."

These quotations demonstrate, Judge Ray holds, that it was known more than 25 years ago that sewage discharged continuously into an air tight tank through an inlet below the surface of the mass of sewage therein, such tank being provided with an outlet opening from below the surface of such mass, would wholly dissolve into liquids, that is, become liquefied, leaving no sludge or deposits, and that the liquid would be almost entirely odorless; that a scum limited in thickness would form on the top of the mass of sewage; that this liquefying process was self-acting in the absence of oxygen; and that the probable cause of this process of liquefaction was the action of "vibrious or anærobic bacteria which, according to Pasteur, are destroyed by oxygen and which manifest their destructive activity only in vessels from which the air is excluded." No mention is made of the exclusion of light, but the operation was carried on in a dark tank, as light was necessarily excluded from the vessels employed by Mouras.

As early as 1878 the German Empire granted to Dr. Alexander Muller, of Berlin, a patent for "A process of disinfection, purification and utilization of putrescent waste liquid or liquid sewage, by the rational cultivation of fomenting leaven-like organisms." After pointing out and referring to prior methods and their failure or inefficiency, the patent says:

"Now, whereas the former disinfecting methods had for their essential object to obviate as far as practicable any phenomena of putrefaction (corruption or decomposition) the process herein described, on the contrary aims at the methodical cultivation of those small, "leaven-like" organisms to the viability of which modern science has traced the so-called "self-unmixing" processes, namely, acidification, fermentation, putrefaction, decay or the like, in accordance with the rules of physiology, with a view to bringing them into requisition in the task of precipitating out the liquid waste-substances or bringing about their complete mineralization (i. e., reduction to simple inorganic compounds)."

It thus appears that the idea or conception of producing and cultivating and housing these micro-organisms was not new or original with the patentees of the patent in suit. This point is confirmed, Judge Ray believes, by the English patent to Lake, 1881, No. 5391, and the British patent to Adeney and Parry, No. 3312, 1891.

Discussion of Cameron Process Patent.—Whether we are to cultivate ærobes or anærobes for the purification of sewage, Judge Ray states, the conception and principle involved is precisely the same. Each colony has its work; the one in the presence of oxygen and light the other in the absences of oxygen and light. To cultivate ærobes we have a tank open to light and air and introduce oxygen; to cultivate anærobes we have air tight tanks like Mouras, thereby excluding oxygen and constructed of such material as to exclude light. For anærobes the less agitation the better. But, after all, we provide the conditions for the development and growth of each. The conception is that if we desire their action we must have their presence and if we would have their presence we must provide the conditions under which they generate and multiply.

Cameron's conception, according to Judge Ray, was to provide an "artificial method" for "the liquefaction and purification of sewage" by the action of anærobic bacteria developed in a pool of the sewage under proper conditions. But this had been done before, he states, even if we may say that nature's method and means of doing a thing become an "artificial method" of doing the same thing when we provide a new place, an artificial place, or a place, like a tank, constructed by human hands, in which nature by its own instrumentalities is to perform its own process. The remainder of the decision, regarding the patent, is so important that it is reprinted practically unabridged.

The patentee declares "The invention consists in certain methods of developing *in a flowing current of sewage* bacteria capable of dissolving the mass of solid organic matter contained therein," and, 2, "of subsequently utilizing the so developed bacteria in liquefying the *mass of organic matter contained in the flowing current.*" If this means what it says nothing of the kind is done. The bacteria or micro-organisms are not developed *in the "flowing current of sewage"* and cannot be effectually. They are developed in that part of the sewage which is at rest and which has been brought to a "stand still" secluded in a pool and which must remain at a "stand still" below the flowing current until the bacteria are developed and have actually liquefied it. Non-agitation, non-disturbance, non-flowage, are essential to the effectual development and action of the bacteria. The liquids of the sewage that do not require liquefaction flow along through the tank and pass out, but this part does not develop bacteria of the character mentioned. Hence the necessity for the deep tank in which the more solid parts of the sewage may remain at rest in a pool, deposited at the bottom, outside the "flowing current of sewage" for days, while the bacteria develop and work and liquefy this non-moving mass. When liquefied it returns to the flowing current of sewage, becomes a part of it, and passes on. And the bacteria after development do not liquefy "the mass of organic matter contained in the flowing current," but that part of the organic matter which has left the "flowing current" sunk to the bottom of the pool and remained at rest for the development and action of the bacteria. But in any event it is the same "flowing current" of the prior art, as in Mouras, where the sewage entered at the inlet, was, except the fluid, deposited at the bottom of the tank for the development and action of the micro-organisms, or bacteria, and then, when liquefied by the operation of natural laws or processes, liberated and carried along in the flowing current of fluids, and as in Moncrieff and Adeney, fully described. Philbrick, Waring, Champaign and Urbana had the same floating current and by-pool.

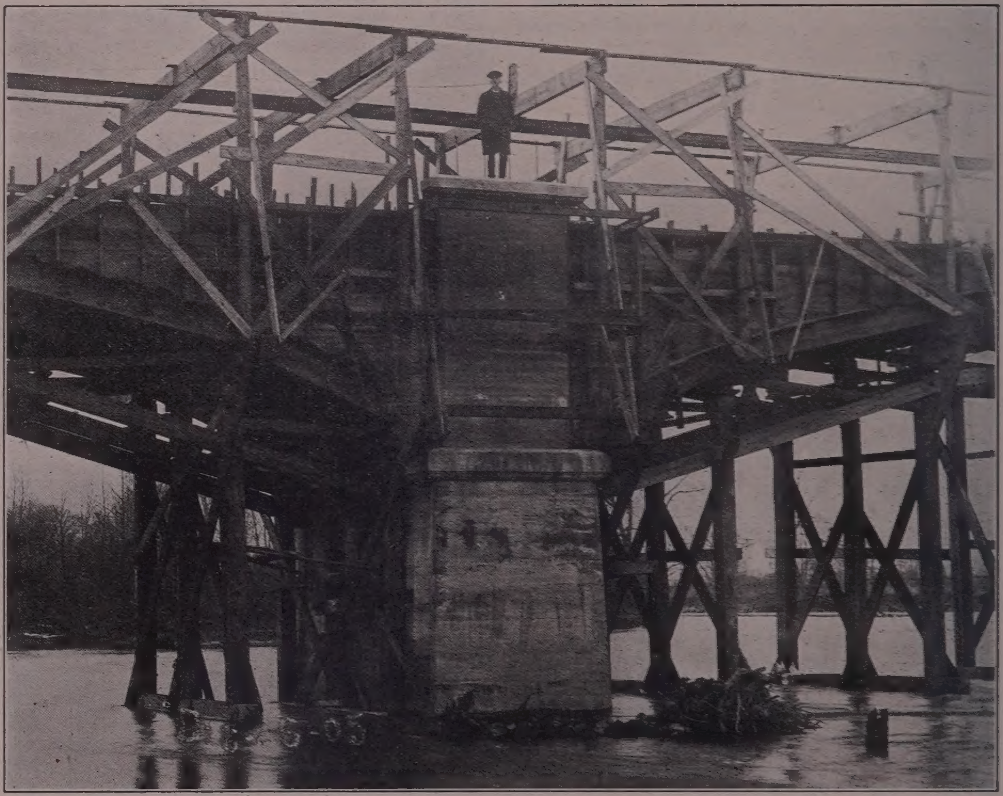
All this was indicated and pointed out to him in the prior art with which he is presumed to have been familiar. The conception was not new or novel. I fail to discover any new or novel method of developing bacteria, or of allowing or permitting or enabling them after development to do their work of liquefying the sewage. They develop as they always had done and always will do under certain conditions and when developed they liquefy certain materials as they always had done and as they always will do if not prevented. Pasteur discovered the difference between and gave the names "ærobic" and "anærobic" to certain bacteria or micro-organisms to distinguish those which develop and exist in the presence of free oxygen from those which do not. Mouras and Moigno and many others knew that an air tight receptacle did not contain free oxygen and that therefore ærobes did not liquefy the sewage contained in such an air-tight receptacle or tank. As already stated Mouras and Moigno had discovered and published to the world the fact that sludge would not form in such a sewage receptacle or tank having a submerged inlet and outlet. Cameron did not, as shown, even discover "the scum." His tank must be air tight in the beginning of nature's process going on therein, but when "the scum" is once formed it may be opened. Therefore his discovery of the utility of "the scum" is not patentable invention. He has dispensed with nothing, he has added nothing. He has, we will assume, found in nature's process an aid not to his process, but to nature's process, a part of it, and Cameron utilizes it at a later stage in that he may leave his air tight tank open after the bacteria have been developed and have constructed their own roofing. This discovery, if it be Cameron's, has not enabled him to even modify the tanks of the prior art. Clearly the formation of this scum or its use is not a part of a patentable process. A principle is not patentable.

It is when the term process is used to represent the means or method of producing a result that it is patentable and it will include all methods or means (not nature's) which are not effected by mechanism or mechanical combinations. We may have a valid patent for the means or methods of putting principles into operation so as to produce useful results, but not for nature's means and methods. These are common property and cannot be appropriated and monopolized by any one.

It was discovered years ago, before Cameron came into the field, that sewage, in an air tight tank, or receptacle of any kind, having an inlet and an outlet, both submerged therein or opening in the tank below the level of the contents, would generate or develop active bacteria, or micro-organisms, which, feeding on such sewage and on the newly arriving sewage, would so act upon it as to liquefy it permanently, leaving no great amount of residue or sludge. It is true that the principle was not fully comprehended and understood, but enough was known and understood to enable the prior art to construct and use their "septic tanks" with a flowing current of sewage secluding in the tank under the proper conditions a pool for the development and action of the bacteria. This result was obtained in the prior art by the process of the patent in suit. This development of bacteria is a fundamental truth in nature. In patent law it is a principle. It is a process of nature but a principle and not patentable. But if patentable, Cameron was anticipated.

Take the means for bringing this principle into operation, for making it serviceable to man, the process of liquefying sewage by anærobic action. We have, with Cameron, the air tight tank or receptacle, with the inlet and outlet demanded. The raw sewage flows in and remains at rest while the liquids coming in and those produced by the anærobic action flow out. Nothing whatever is done to the sewage after its arrival. It must be left undisturbed. In fact it must not undergo any process whatever except the natural one; that is, let nature take its course. It is like a process for fomenting cider or improving whiskey. Run it into the barrel or tank where it will not freeze and let it alone. But all this had been done before. Assume that Cameron discovered that these anærobes would, in an air tight and dark receptacle, construct a covering for themselves by the formation of the scum. His process has nothing to do with that. It is a principle and not patentable. But he did not discover it as we have seen. Moigno twice describes it. But, it is said, he has improved the means and therefore has an improved process. But we have seen that his process is old, his means old, except, possibly, in some mechanical details. In the sewer pipes, entirely outside of, and away from, the tank, he has put in the old settling tank or catch basin of the prior art for stone, iron, bones, etc. Outside the tank at the other end he has attached an aerator, or more properly, aerating means which deals with the liquid after it has left the tank, and then he adds to that the filter, all old devices. Each performs its old function in the old way and each acts independently of all the others and is independent of the tank and the process going on there. This is mere aggregation and not patentable.

The process described in claims 1, 2, 3 and 4 is nothing more nor less than the process of Mouras and of Moncrieff and the ones in use at Champaign and Urbana. It should be mentioned that Mouras took out a patent in the United States in 1882 for his process, No. 268,120, and that he had a device in the tank itself for intercepting bone and other hard substances. The same is true of claim 21, for it cannot be doubted that the scum existed in all those cases and did its work, although its office or function in nature's process may not have been understood. The process described had become public property in the United States before the patent in suit was applied for. To hold these claims valid would make an infringer of every one who shall use the Mouras tank with its inlets and outlets. Certainly so should such use apply to the broadened inlets and outlets of the prior art; that is, the devices of the prior art used in sewage disposal, etc., prior to the Cameron patent. I cannot discover any new "conception" in the patentable sense in the patent in suit. I do not doubt that it improves some of the mechanical devices at the outlet. I do not doubt that it was a "good thing" to connect the aerator to the "septic tank" and then connect that to the filter, but I do not find patentable invention in so doing.



Centering Used at One of the Piers of the Goshen Bridge.

The Saratoga Septic Tanks.—The plant at Saratoga Springs (Eng. Record, Jan. 21, 1905) does not have either the inlet or the outlet of the patent in suit nor its aerator, Judge Ray says, whose opinion reads as follows:

Much more nearly do we have the outlets of the Wigner and Meyer patents, found in the prior art before Cameron came into the field. We do not have the same combination of elements, taken as a whole, found in any one of the "apparatus" claims of the patent. If they, or any one of them, have any validity whatever in view of the prior art they must be very narrowly construed and limited to the inlet and outlet and other devices shown therein. As so constructed and limited defendants' sewage plant does not infringe any apparatus claim. Complainant cannot claim the "septic tank" broadly for it is in the prior art. He cannot claim the inlet described broadly for that, too, is in the prior art. Even if he may claim his specific outlet broadly defendant does not infringe for he does not use it. As to the process claims, claim 1 is plainly invalid, anticipated and long in use prior to the Cameron patent. As to the other process claims, while in my opinion invalid as not disclosing patentable invention in view of the prior art, and because of prior public use, etc., still, if either has any validity, in view of the prior art, it must be narrowly construed and limited to the exact process performed by the means described in the Cameron patent, and as so construed and limited defendant does not infringe. The Cameron process, if it be a process, consists in constructing a tank in a certain way in which to enable a process of nature to be performed, and as he has borrowed the tank, the inlet, and, in the main, the outlet from the prior art, changing or improving no element, except it be the outlet apparatus, and produces no new result the defendant does not infringe in using the old tank, and inlet with an outlet entirely different from Cameron to produce the same result. In fact the inlet, and outlet, and aerator, and filter, all are essentially different from Cameron. But I prefer to base my decision on the broad ground that the claims in suit of the Cameron patent, in view of the prior art, are invalid for want of patentable invention. Cameron may have carried forward discovery in this art and may have improved means but as defendants' process and apparatus are clearly differentiated there is no infringement. Not every improvement in an article or process is invention. The improvement must be the product of original conception.

A School of Railway Engineering has recently been organized at the University of Illinois with courses in civil, mechanical and electrical engineering, arranged especially to provide training for railway service. In addition the department of economics of the College of Literature and Arts has added to its courses of training for business a course in railway administration. In this course special attention is given to corporate and financial organization, economic location and traffic management, including rate making, and to railway accounting and auditing. In the three engineering courses more time is given to the study of economics than is usually given in engineering courses, and the course in administration comprises enough engineering work to give students an understanding of the technical problems arising in the engineering departments.

The Completed Bridge Near Goshen, Ohio.

The Highway Bridge Near Goshen, Ohio.

By Edw. Stingel, New Philadelphia, Ohio.

There has recently been built near the village of Goshen, Tuscarawas County, Ohio, where the New Philadelphia-Trenton highway crosses the Tuscarawas River, a five-span, arched, reinforced concrete bridge of a clear width of 16 ft. and a total length of 493.5 ft. All the arches are similar in design and construction, each having a clear span of 83 ft. 6 in., a rise of 8.35 ft. and a thickness of 18 in. at the crown, increasing to 36 in. at the skewbacks. They are reinforced with two sets of 1.25-in. Thacher patent bars spaced 18 in. on centers and placed in the usual way. The arches are of the five-radii type. The radii of the intrados are 128.12, 26.45 and 2.83 ft. and the extrados has a single radius of 141.49 ft. The piers are 8 ft. 6 in. thick at the springing line and are built with a batter of 1 in. in 24 in. The wing walls are built at an angle of 20 deg. 14 min., with the spandrel walls, and are 21 ft. long.

Forty piles were driven for each pier foundation and 84 were driven for the south abutment. The north abutment, being located on a bed of hard-pan required no piling.

Cast-iron noses, cast in ten sections, were built on the upstream ends of the piers.

The conditions of the calculations, covered by the specifications, were as follows: Weight of the concrete was taken at 150 lb. per cu. ft., the weight of the earth fill was taken at 120 lb. per cu. ft., and the paving was taken at a weight of 150 lb. per sq. ft. and to occupy a depth of 12 in. A maximum live load of 125 lb. per sq. ft. was provided for, or the following concentrated loads: a 15-ton steam road roller 11 ft. between axles, 6 tons on forward wheel 4 ft. wide, and 4.5 tons on each of the rear wheels 5 ft. between centers and 20 in. wide. The modulus of elasticity of the concrete was taken at 1,500,000 lb. per sq. in., and that of steel at 30,000,000 lb. per sq. in.

The maximum compression allowed on the concrete, exclusive of temperature stresses, was 500 lb. per sq. in., and including stresses due to 40° variation in temperature 600 lb. per sq. in. It was further provided that the maximum stress on the steel ribs in the concrete arches should not exceed 18,000 lb. per sq. in., and should be capable of taking the entire bending moment of the arch without aid from the concrete and have a flange area of not less than 1/150 part of the total area of the arch ring at the crown; and further that the actual stress in the steel when imbedded in and acting in combination with the concrete should not exceed twenty times the allowable stress on the concrete. Either soft or medium steel could be used, but if soft steel were used it was required that it should have an ultimate strength of 54,000 to 62,000 lb. per sq. in.

Three different grades of concrete were used in the different parts of the bridge: in the spandrel walls a 1:3:6 (to pass through a 2-in. ring); in the arch rings a 1:2:4 (to pass through a 1.5-in. ring), and in the piers and the abutments a 1:3½:7 (to pass through a 3-in. ring). Diamond, Nazareth and Whitehall Portland cements were used, Diamond being used exclusively in the arch rings. There was no occasion for rejecting any cement.

The gravel and sand were taken from the river bed, washed and separated in one operation. This water-washed gravel was considered to be a very desirable aggregate, as only the hardest gravel can withstand continual water washing.

The stones in the old piers and abutments were in excellent preservation and were used in the new piers and abutments. In placing them they were separated at least 4 in., and were thoroughly cleaned and washed, before placing, to enable the concrete to adhere to them.

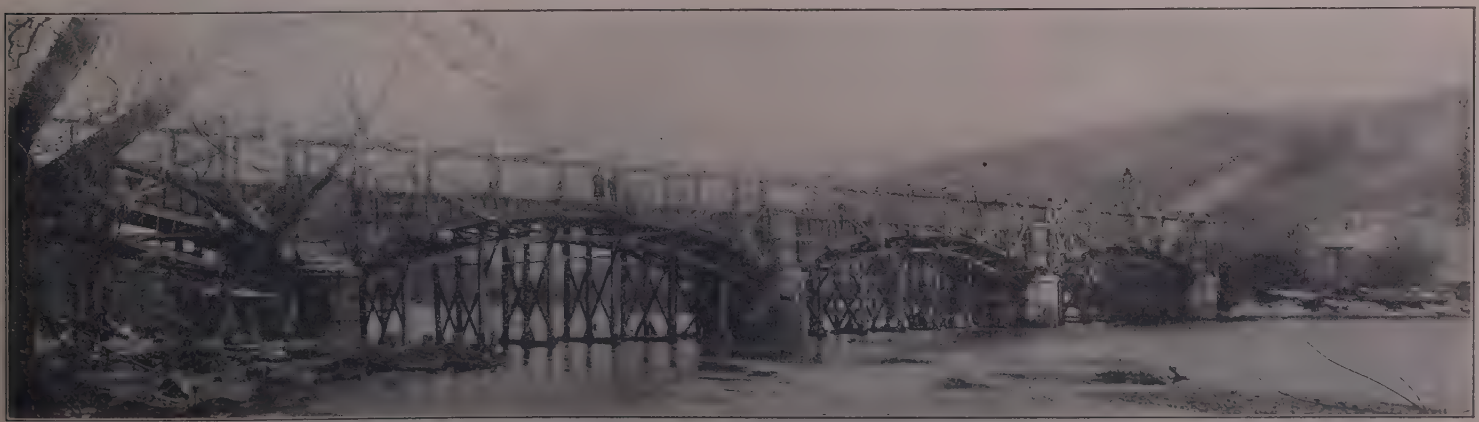
The old bridge, a four-span bowstring truss of a total length of 368 ft., was used to support the 2,000 lb. drop hammer pile driver used in driving the centering piling. After the centering piling was driven and the piers built the old bridge was removed.

A continuous mixer of one-half cubic yard capacity was used in concreting the piers; this mixer was moved from pier to pier as the work progressed. The main mixing plant, equipped with a Smith mixer of a 1 cu. yd. capacity, was located at the extreme north end of the bridge. The concrete in the spandrel walls and the arch rings was mixed at this plant and carried out to the desired place on the bridge in a 1-cu. yd. turnover bucket by an I-beam track directly over and in the middle of the bridge, supported by bents as shown on the accompanying photographs. An endless wire rope attached to the drum of a small hoisting engine located near the mixing plant furnished the means of operating the bucket.

The first and last arch rings were completed on Nov. 30 and Dec. 9, 1905, respectively. The centering was struck Jan. 1, 1906. The deflection at the crown of the first and last arches was 0.7 in., and that of the second and fourth was 0.5 in. The middle span did not deflect any measurable amount.

Joints, providing for the rise and fall of the arch due to the changes in temperature, were made at the junction of the spandrel walls and the pilasters at the piers and the abutments, by applying hot coal tar to the pilasters to the thickness of ⅛ in.; the weather being cold, it soon hardened. The specifications provided for additional joints at points at one-sixth of the span from the ends of the walls, but these were not put in, neither were the walls reinforced, with the result that the spandrel walls are cracked at points about one-eighth of the span from their ends. The pipe railing posts reduce the sectional area of the spandrel walls 42 sq. in. where the cracks occurred; however, the cracks run toward the point of one-sixth of the span from the end. The writer is of the opinion that these cracks would not have developed had the centering not been removed before the cement was properly set; however, they in no way threaten the stability of the structure.

The centering was made up of eight transverse bents to each arch and had three piles to each bent, braced with two 2x10-in. timbers and capped with a 3x12-in. timber. The 2x12-in. joists were supported by 10x12-in. timbers. The curve strips were sawed to the desired curvature and nailed to the joists. Seven-eighths-inch lagging, tongued and grooved, was used throughout. The centering was lowered by means of double white



General View of the Bridge Near Goshen, Ohio, During Construction.

oak wedges of a length of 24 in. and a width of 12 in. and were 8 in. thick at the big end and 2 in. thick at the small end.

The centering was struck before the spandrel walls were built; by so doing, the deflection of the arch rings could not be detected in the spandrel walls, which is noticeable in so many masonry arches; a notable example being the Y bridge at Zanesville, Ohio. In building the centering provisions were made for a deflection of 1/800 part of the span.

All exposed surface was finished with a 1:2 mortar, mixed very dry, of a thickness of ¾ in. and was in all cases carried up and rammed with the concrete; and after the forms were removed all surface, excepting the intrados of the arch rings, was washed with a neat cement grout. Work was carried on when the temperature was 12° below zero, Fahrenheit, with no noticeable bad effect on the concrete. Hot water and salt were used to prevent freezing.

The reinforcing bars in the arch rings were connected by lapping them from 14 to 16 in. only, and were not anchored.

The original plans provided for a concrete railing, but a galvanized pipe railing was substituted. This pipe railing was built in panels of 9 ft. 9 in. and was made up of one 3-in. pipe and two 2.5-in. pipe supported at the pilasters and the crowns of the arches by concrete posts, and by 3-in. pipe posts at the intermediate points.

The location of this bridge is anything but an ideal one for an arched bridge; the river valley is very flat on both sides, and to provide for the same waterway as before construction, the arch plan necessitated the raising of the roadway grade 4 ft., and this requires the use of rather steep approaches.

The architectural treatment is simple, to harmonize with the surroundings. The spandrel walls are finished with a continuous coping running from end to end of the bridge. The arch rings are emphasized by projecting them 2 in. beyond the spandrel walls, while the pilasters at the piers and the abutments project 12 in. beyond the spandrel walls. A continuous coping is carried around the piers directly below the arch. Wherever possible the corners were beveled. The springing lines of the different arches are all built to the same elevation, the drainage being effected by raising the spandrel walls from both ends toward the crown of the middle span. After the fill had settled for a period of nine months the roadway of the bridge was laid, paving brick being used for the wearing surface.

The structure is slightly disfigured with efflorescence. The efflorescence is more noticeable at the joints made of the end of a day's concreting than elsewhere.

The contract price was $24,700, but the original plans were changed, costing an additional amount of $12,200. The total cost of the bridge was, therefore, $36,900.

This bridge was built by Mr. J. B. Westhafer, of New Philadelphia, Ohio, under the direction of Mr. Paul R. Murray, county engineer, New Philadelphia, Ohio. The Concrete-Steel Engineering Co., of New York, were the consulting engineers.

THE PRESENT CONDITION OF THE BATTERY TUNNELS connecting the lower end of Manhattan with Brooklyn is as follows: The north tube was connected on Dec. 16, 1906, and the south tube on March 1, 1907. The shields have been removed from both tunnels. The cast-iron lining has been completed in the north tube, but still remains to be joined up in the south one. When this work is completed the tunnels will be entirely finished, and will be ready for operation as soon as the tracks are laid and the block-signal system installed.

Power Plant of the Sperry Flour Co., Los Angeles, Cal.

By W. F. Durand, Professor of Mechanical Engineering, Leland Stanford Jr. University.

The insistent demand in the industrial world, especially during the opening years of the present century, has been for power upon the very lowest possible terms of payment. This has stimulated engineers, and in particular those concerned with power plant design and service, to a renewed and critical study of the elements entering into such problems of engineering design. Such study has been directed along two main lines: first, the determination of such forms and types as shall present in themselves the highest possibilities of economy, and, second, the combination of such elements in the most effective way looking to the resultant economy as a whole.

Runway Used in Handling Materials, Goshen Bridge.

Any given problem of power plant design and arrangement must, of course, be worked out with reference not only to general engineering principles, but also with special regard to local and particular conditions. Among the power plants with special reference to high economy which have been recently installed on the Pacific Slope, special points of interest are found in the plant of the Sperry Flour Co., at its Angelus Mill in Los Angeles. This plant was designed and installed in 1904 by the Tracy Engineering Co., and contains certain special features which should be of interest to all who are concerned with engineering work of this character.

The general conditions under which this plant must operate are as follows:

(1) Power amounting to about 125 h.-p. must be developed for 10 hours per day and for 300 days per year, with close uniformity as to speed and certainty as to service.

(2) The fuel will naturally be the crude oil which is found at or near this locality, and which averages not far from 18,500 B. t. u. per pound as it comes to the burners.

(3) Water for condensation is scant in supply and relatively high in cost, and if rejected after passing once through the condenser, the expense chargeable to condensation would form a serious item in the general schedule of power costs. This naturally points to the use of a cooling tower and the partial refrigeration of the water by evaporation in the tower. The loss thus introduced by evaporation, together with the small percentage of feed water loss in other ways, then represents the current demand for water, an amount insignificant in comparison with the total demand when no cooling tower is employed. Under these general conditions, the requirement is for power at the minimum of cost per horse-power unit delivered to the mill.

The general solution of this problem is contained in two simple propositions:

(1) The full liberation of the energy of the fuel.

(2) The reduction to a minimum of all streams of energy leaving the power house in the form of heat, and the consequent elevation to a maximum of the amount which leaves it as mechanical work.

The full liberation of the energy of the fuel is the problem of combustion, and, with oil fuel, relates solely to the burner and to the furnace.

The streams of energy which may leave the power house as heat may be classified in the typical case under the more important heads as follows:

(1) Waste heat of the fuel by way of the stack.

(2) Heat equivalent of steam required to atomize oil.

(3) Heat carried away in the condensing water, representing most of the heat rejected from the engine.

(4) Auxiliary exhausts, either into the condenser and thence in part out with the condenser water, or direct to the air outside.

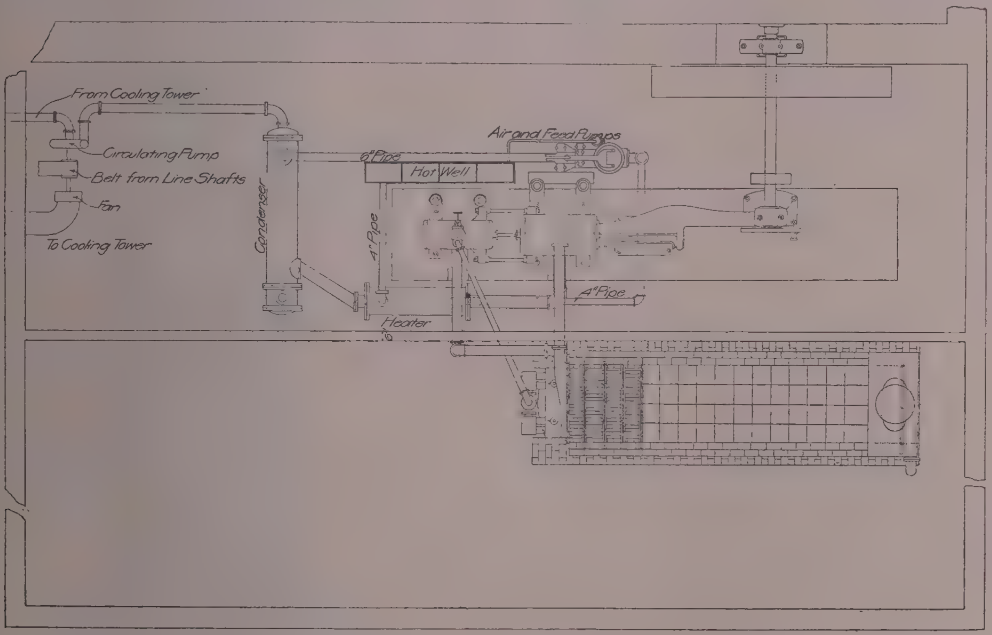
We may now turn with advantage to an examination of the details of this plant with special reference to the means adopted for reducing the various heat wastes as classified above.

The plant as a whole consists of the following items with characteristics as briefly given under each heading.

Boiler.—The boiler is single, of the Edge Moor water-tube type, and contains 735 sq. ft. of water heating surface and 100 sq. ft. of superheating surface. In this boiler the tubes, which are slightly inclined to the horizontal, receive their supply at the lower end from a common header and discharge at the upper end, likewise into a common header, the size of headers and mode of connection with the drum being specially designed with reference to a free and unimpeded circulation.

High-Pressure Superheater.—This consists of six 4-in. tubes 18 ft. long, placed immediately above the drum of the boiler and thus exposed to the escaping gases at their hottest point. The steam is admitted to these tubes from the rear header of the boiler, whence it passes to the front end, and thence to the high-pressure cylinder.

Low-Pressure Superheater or Intermediate Reheater.—This superheater or intermediate reheater is made up of cast-iron headers and 2-in. steel tubes located directly over the high-pressure superheater, and is thus exposed to the waste gases after they have left the superheater below. The exhaust from the high-pressure cylinder makes a double pass through these tubes and then from the final header at the front of the boiler is led to the low-pressure steam chest.



General Plan of Power Plant of Sperry Flour Company.

Oil Burner.—The burner fitted is of the earlier Hammel type, producing a fan-shaped flame driven from the front of the furnace toward the bridge wall, in accordance with usual practice in oil-burning furnace equipment.

Engine.—The engine is of the well-known Nordberg Corliss type, tandem compound and condensing, with cylinders 9 and 20 in. in diameter and with 30-in. stroke. The high-pressure cylinder, which is jacketed, is placed outboard, and is fitted with Nordberg's special long-range valve gear. The low-pressure cylinder is inboard, unjacketed, and is fitted with cut-off adjustable by hand for the adjustment of the subdivision of the power between the two cylinders.

Condenser.—This is of standard form, of the surface type, and made by the Tracy Engineering Co., engineers for the installation of the plant. It contains about 300 sq. ft. of cooling surface and is located as shown in the general plan near the head of the high-pressure cylinder and somewhat below the level of the exhaust outlet of the low-pressure cylinder.

Cooling Tower.—This is of standard form built from designs by the Tracy Engineering Co., and is of steel, 6 ft. in diameter and 18 ft. high, surmounted at the top by a steel hood to prevent waste of the fine spray by air currents.

Circulating Pump.—The circulating pump is of the centrifugal type and is operated from a line of shaft of the mill, which is driven by belt direct from the flywheel. On the extended shaft of this circulating pump is located a fan which supplies air for the cooling tower. The suction of the circulating pump is connected directly to the base of the cooling tower, and the delivery from the condenser to the top, so that the water is thus sent round and round its cycle, including the condenser, cooling tower, pump, condenser, etc., with only such loss as may result from the evaporation in the tower.

Air Pump.—The air pump is of the vertical belt driven type, operated directly from a pulley on the engine shaft. It is so located with reference to the condenser that the condensed water will gravitate naturally to the base of the pump. The discharge from the air pump in turn gravitates through a feed heater to the hot well proper.

Exhaust Heater.—Between the low-pressure cylinder of the engine and the condenser, a closed heater is installed through which the exhaust steam is passed on its way to the condenser. The feed water circulates on the outer side of the tubes in the heater and absorbs a part of the heat of the exhaust steam, which would otherwise escape from the condenser with the cooling water.

Hot Well.—A hot well of ample proportions is located between the heater and the boiler feed pump. The feed water is discharged from a heater into one end of this hot well and the suction of the feed pump is taken from the opposite end. The hot well is further divided into compartments in which excelsior is placed to act as an oil purifier in the water. The compartment nearest the feed pump receives the drain from the jacket of the high-pressure cylinder. In this manner the water condensed in the jacket is returned to the boiler without further loss.

Boiler Feed Pump.—The main boiler feed pump is located at the side of the air pump from which it is driven by a bell crank attached to the air pump shaft. The feed pump suction is connected direct to the hot well and the feed water is forced from the pump through a covered feed pipe to the boiler.

In addition to the main boiler feed pump an injector is supplied for service when the mill is shut down or in case of accident to the main pump.

Oil Pumps.—The supply of oil to the burner is pumped by a belted Scotch yoke pump. A duplex steam pump is provided for use as an auxiliary feed for getting up steam or in case the main pump should be disabled.

The entire cycle for the feed water is thus seen to include the following items beginning with the feed pumps: Feed pump, boiler, high-pressure superheater, high-pressure cylinder, low-pressure superheater, low-pressure cylinder, exhaust steam heater, condenser, air pump, exhaust steam heater, hot well and feed pump.

It is obvious that the two general conditions for power plant economy are:

(1) The most efficient combustion of the fuel, resulting in the liberation of the largest possible amount of heat energy per pound of fuel fed to the burners.

(2) The maximum utilization of the heat energy thus liberated. Or, otherwise, as has been noted above, the reduction to a minimum of the streams of energy flowing from the power house under the form of heat.

Condition (1) was met most admirably by the burner employed. With proper adjustment as to oil, steam and air inflow, a dense white smokeless flame is produced, implying practically a perfect combustion with small excess of air, and admitting of ready control over a considerable range of conditions as to power output.

Referring to general condition (2) it will be noted in this design that all auxiliaries are mechanically driven and that steam from the boiler is led to three places only: (1) the high-pressure cylinder; (2), the high-pressure jackets; (3), the oil burners.

It will be further noted that aside from radiation there are but two streams of heat flowing from the building:

(1) By way of the waste furnace gases in the stack.

(2) By way of the condenser cooling water.

Heat stream No. 1 is reduced to a minimum by three special means:

(a) The provision of an ample proportion of heating surface in the boiler, as a consequence of which the waste gases are well reduced in temperature by the time they reach the superheaters.

(b) The high-pressure superheater.

(c) The low-pressure superheater.

As a result of this serial abstraction of heat, the final temperature of the escaping gases is reduced down to values only slightly above, or it may be even somewhat below, the temperature of the steam within the boiler.

Heat stream No. 2 is reduced to a minimum by three principal means:

(a) The use of high expansion in the engine and thus, by thermodynamic means, the transformation of the maximum proportion into mechanical work and the rejection of the minimum proportion as heat in the exhaust steam.

(b) The use of moderately superheated steam in both high-pressure and low-pressure cylinders, provided by the two superheaters as previously described, the action of such superheat being to reduce the activity of the collateral cast-iron cycle of the cylinder, with its resulting loss by cylinder condensation. This tends to permit a nearer approach to the realization of the thermodynamic efficiency which belongs to the range of expansion and temperature range employed in the engine.

(c) The use of an exhaust steam heater to effect a farther abstraction of heat from the exhaust and transfer direct to the feed, before it gives up any share of its heat to the cooling water.

Test Results.—In January, 1904, this plant was subjected to a careful and comprehensive test by

Mr. Edward S. Cobb, of Los Angeles, Cal., and with the following general results:

Evaporation Results.

1. Duration of test run	6	hours
2. Total pounds of water fed to boiler during test	9633	lb.
3. Water fed to boiler per hour	1605.5	“
4. Total oil consumed during test	714.5	“
5. Oil used per hour	119.1	“
6. Water evaporated per pound of oil (actual conditions)	13.482	“
7. Equivalent evaporation from and at 212° F. per lb. oil	15.51	“
8. Pounds of water evaporated per sq. ft. heating surface per hour	2.185	“
9. Horse power developed by boiler during test (A.S.M.E. rating)	53.56	
10. Square feet water-heating surface per horse-power (A.S.M.E. rating)	13.72	

Temperatures.

1. Average temperature uptake under damper	280.00°	F.
2. Average temperature gases in low-pressure superheater	301.75°	F.
3. Average temperature steam entering low-pressure superheater	236.27°	F.
4. Average temperature steam leaving low-pressure superheater	300.16°	F.
5. Average temperature steam entering low-pressure cylinder	289.16°	F.
6. Average temperature steam entering low-pressure cylinder above temperature corresponding to pressure on receiver gauge	49.16°	F.
7. Average temperature steam entering high-pressure cylinder	372.08°	F.
8. Average temperature corresponding to pressure on boiler-room gauge	371.40°	F.
9. Superheat above the temperature corresponding to the pressure as shown by gauge	0.68°	F.
10. Average temperature of air pump discharge	105.75°	F.
11. Average temperature of feed water leaving exhaust heater	118.66°	F.
12. Average temperature after being heated by jacket drain	154.00°	F.
13. Loss in temperature of feed water by weighing and conducting to the boiler	39°	F.
14. Average temperature feed water entering boiler	115.00°	F.
15. Average temperature condensing water supply	90.25°	F.
16. Average temperature condensing water discharge	100.08°	F.

Pressures.

1. Average steam pressure as shown by boiler room gauge	162.25	lb.
2. Average steam pressure as shown by engine room gauge	153.83	“
3. Average receiver pressure as shown by receiver gauge	10.00	“
4. Average vacuum as shown by gauge	26.9	in.

City Water Supplied to Plant.

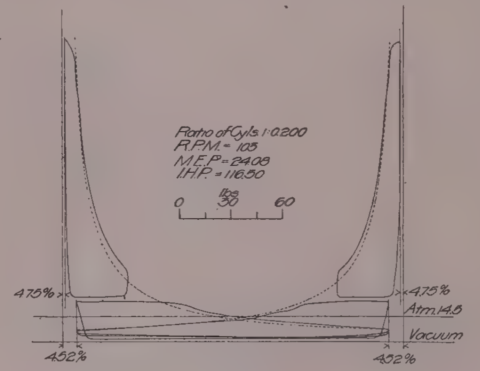
1. Total city water supplied to plant during test	7479	lb.
2. Total city water supplied to plant per hour	1246.5	“
3. Total city water supplied to plant per horse-power-hour	10.01	“
4. Total city water supplied to cooling tower during test	5935	“
5. Total city water supplied to cooling tower per hour	989.1	“
6. Total city water supplied to cooling tower per horse-power-hour	7.95	“
7. Total city water supplied to cooling tower in percentage of feed water to the plant	61	per cent.
8. Total city water weighed and fed to condenser to supply wastes by fuel oil burner and leaks in excess of air pump discharge	1544	lb.
9. Total city water as in (8) per hour	257.33	“
10. Total city water as in (8) per horse-power-hour	2.06	“
11. Steam supplied to fuel oil burner during test	384	“
12. Steam as in (11) per hour	64	“
13. Steam used by burner to burn one pound of oil	0.537	“
14. Total city water fed to condenser as in (8), less the amount of water consumed by burner during test	1160	“
15. Total water as in (14) per hour	193.3	“
16. Total water as in (14) per horse-power-hour	1.55	“

Engine Data and Economic Results.

1. Diameter high-pressure cylinder	9	in.
2. Diameter high-pressure piston rod	$1^{15}/_{16}$	“
Area high-pressure piston	63.61	sq. in.
Area high-pressure piston rod	2.94	“
3. Average working area high-pressure piston	62.14	“
4. Diameter low-pressure cylinder	20	in.
5. Diameter low-pressure piston rod	$2^{15}/_{16}$	“
6. Average working area low-pressure piston	310.6	sq. in.
7. Average revolutions per minute of engine during trial	103	
8. Piston speed in feet per minute	515	
9. Average mean effective pressure in high-pressure cylinder during trial	65.01	lb.
10. Average mean effective pressure in low-pressure cylinder during trial	12.68	“
11. Average indicated horse-power developed in high-pressure cylinder during trial	63.04	
12. Average indicated horse-power developed in low-pressure cylinder during trial	61.46	
13. Total average indicated horse-power developed by engine during trial	124.5	
14. Feed per indicated horse-power per hour for steam fed to oil burners	.51	lb.
15. Feed per indicated horse-power per hour for steam condensed in jacket	1.55	“
16. Feed per indicated horse-power per hour for steam to high-pressure cylinder determined from air pump discharge	10.83	“
17. Feed per indicated horse-power per hour, total for engine, (15) + (16)	12.38	“
18. Feed per indicated horse-power per hour total for plant, (14) + (17)	12.89	“
19. Fuel oil per indicated horse-power per hour for steam fed to burners	0.0379	“
20. Fuel oil per indicated horse-power per hour for steam fed to engine	0.9187	“
21. Fuel oil per indicated horse-power per hour for total steam to plant	0.9566	“
22. Calorific value of oil in B.t.u. per pound	18,757.8	“
23. Specific gravity at 59° Fah.	0.942	
24. Percentage of sulphur	0.95	per cent.
25. Percentage of water	0.23	“
26. Efficiency of boiler	79.8	“
27. Heat input at furnace required for one I. H.P. hour, output	17,944	B.t.u.
28. Heat supplied to feed water per I. H.P. hour, including steam for main engine and for jackets	13,763	“

Reference by way of comment may be made on a few of the items above detailed.

The low range of temperature for the escaping furnace gases shows the efficiency of the boiler heating surface and of the two superheaters acting all in series in removing the heat liberated in the furnace. The low degree of superheat in the steam entering the high-pressure cylinder implies that the temperature must have been reduced well down toward 400°, or perhaps below by the heating surface of the boiler, leaving but little temperature head above that of the steam in the high-pressure superheater. Again the small superheat at the high-pressure cylinder may in a measure be also accounted for by cooling and loss between the superheater and the cylinder. The average temperature head of about 33° between the gases and the steam in the low-pressure superheater shows also the efficiency of this feature in abstracting heat from the waste furnace gases.



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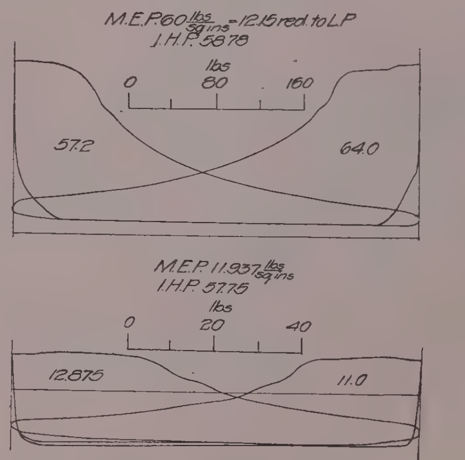


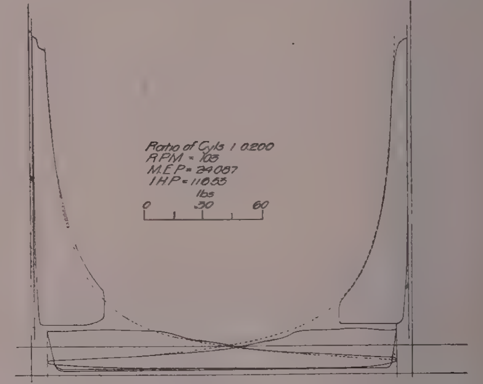
Typical Cards, Set 1.

The loss of heat in the feed water by weighing, amounting to 39°, is to be especially noted. Most of this loss, amounting to about 3.5 per cent. of the heat supplied to the feed, would be saved under the conditions of ordinary operation, and the economic results are fairly subject to a correction in this respect. It is not unfair to assume that by the operation of weighing at least 3 per cent. of the heat supplied was lost under conditions which would not exist in ordinary operation. This would reduce the consumption of oil per indicated horse-power-hour for total steam to plant down to about 0.93 lb., and similar reductions would occur in other quantities.

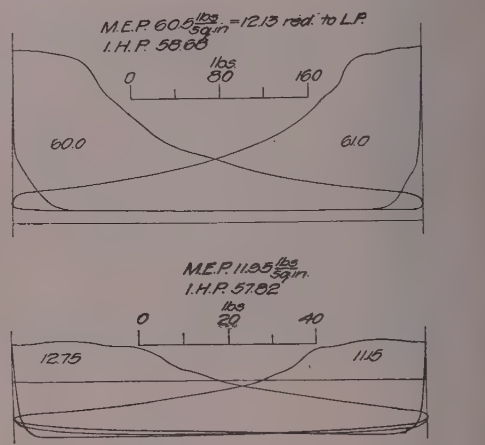
The consumption of city water by a plant operating under the existing conditions is a matter of interest. This will be understood as the extra or makeup water and from the results quoted above the following items may be here noted.

Make up water to cooling tower per indicated horse-power-hour	7.95	lb.
Make up water for steam used in fuel oil burner	0.51	“
Make up water for general leakage per indicated horse-power	1.55	“
Make up water, total per indicated horse-power hour	10.01	“

The larger part of the consumption is naturally for the cooling tower, amounting to about 60 per cent. of the main boiler feed. The amount of outside supply thus required compared with the ordinary condenser in which 30 to 50 times the amount of feed would be continuously required shows impressively the saving in the demand for water which may be realized by the use of the cooling tower.



Combined Cards, Set 1.



Typical Cards, Set 1.

The consumption of steam for the oil burner amounts to a trifle over one-half pound per horse-power-hour at the engine, or about 4 per cent. of the total feed water in circulation. This is in accord with good practice and represents about the results which may be expected with efficient burner and under good economic conditions.

The Water Consumption in St. Paul, Minn., during 1906 was only about 50 gal. per capita daily, a very low figure for an American city of 200,000 population. Mr. L. W. Rundlett, commissioner of public works, attributes this low consumption principally to the fact that most of the services are metered and leaks are detected and repaired quickly. Another fact which undoubtedly contributed to lower the rate of consumption was the abundant rainfall during the summer months, which made less water necessary for lawn sprinkling.

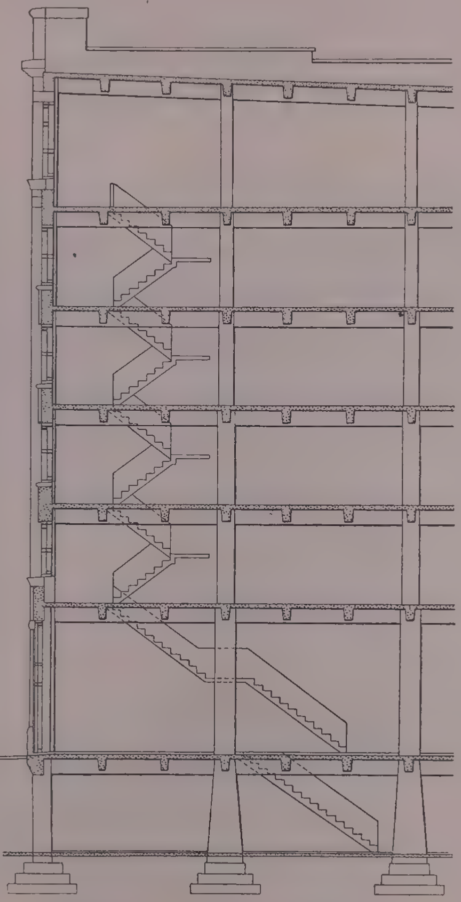
An Electrically-Driven Pumping Plant for Lockport, N. Y.

The proposed new water supply works for Lockport, N. Y., for which contracts were recently let, include: A timber intake crib in Niagara River; 2,625 ft. of 48-in. riveted steel intake pipe, made of ⅜-in. mild steel plate; a concrete pump well, 25 ft. deep and 28 ft. in diameter; an electrically driven pumping plant, housed in an 84x24-ft. pump house, a 30x20-ft. transformer house, and a 60x40-ft. auxiliary boiler and coal house, all brick buildings with steel truss roofs covered with slate; over 68,000 lin. ft. of 30-in. steel conduit pipe leading from the pumping station at North Tonawanda to a 25x120-ft. steel standpipe to be built in Lockport; and about 5,459 ft. of 24-in. distributing main.

Plans and specifications were prepared and proposals asked for three distinct types of pumping machinery as follows: Two horizontal, compound condensing, high-duty, crank and flywheel, steam pumping engines, each with a capacity of 10,000,000 gal. per 24 hr.; three horizontal, 3-stage, turbine, electrically-driven pumping engines, each with a capacity of 5,000,000 gal. per 24 hr.; three horizontal, quarter crank, geared and electrically driven, power pumping engines, each with a capacity of 5,000,000 gal. per 24 hr. Together with the steam pumping plant bids were asked on four horizontal water-tube steam boilers together with the necessary appurtenances. The buildings required to house the electrically-driven pumping plant have already been mentioned and their general dimensions given. In addition to these a brick chimney 75 ft. high, with an inside diameter of 36 in. is required. The structures which would have been required to accommodate the steam-driven pumping plant are as follows: An 84x56-ft. pump house; a 72x40-ft. boiler house; a 75x36-ft. coal house, and a brick chimney 125 ft. high with an inside diameter of 54 in. at the top. The total floor area required for the steam plant is about double that needed for the electric installation. The smaller buildings required for the electric pumping plants, however, was not the factor which determined the selection of that type of plant; it was due rather to the fact that at North Tonawanda electric current can be secured at a very low cost. It is to be supplied from Niagara Falls and will probably cost about $16 per horse-power per year at the switchboard.

The electro-turbine type of pumping plant has been selected. As has been indicated it is to consist of three 3-stage, turbine, pumping units of 5,000,000 gal. capacity each in 24 hr., when operating against a total working head of 287 ft. The relation between the number of stages of the turbine pump and the pressure against which it works, has not been so far appreciated, when economy of operation and long endurance of the pump are desired. Of this total head 202 ft. is due to the difference in elevation between the water level in the pump well and the standpipe when both are full, and the remaining 85 ft. is the calculated friction head in the force main from the pumping station to the standpipe. This working head amounts to 125 lb. pressure per square inch. Each pumping unit is to be a complete machine consisting of a Holly pump driven by a Westinghouse induction motor arranged for 400 volts with a 3-phase, 3,000 alternation current, designed for sufficient energy to provide the water ends with 500 h.-p. at a speed not exceeding 750 r.p.m. The motor and pump of each unit will be bolted to a common frame or bedplate and mounted on a single foundation. Three Westinghouse 500-kw., oil-insulated, water-cooled transformers, with primaries arranged for from 11,000 to 22,000 volts and secondaries for 440 volts, are to be installed. The auxiliary steam plant is to be used for heating the various buildings of the pumping station. This will be done with a 150-h.-p., water-tube boiler. A pumping engine of about 3,000,000 gal. capacity will probably be installed, an old engine of this size being available at Lockport.

The new works at Lockport and North Tonawanda were designed by Mr. Charles A. Hague, New York. The general contract for the buildings and pumping machinery was let to Charles N. Stainthorpe & Co., Lockport, N. Y. Holly pumps and Westinghouse electrical apparatus will be used. The Buffalo Dredging Co., is to build the intake crib and supply and lay the intake pipe. The force main from North Tonawanda to Lockport is to be supplied by the East Jersey Pipe Co., and will be laid by the T. A. Gillespie Co., of New York. The riveted steel standpipe will be built by Walsh's Holyoke Steam Boiler Works, Holyoke, Mass. The estimated cost of the entire installation, including the intake and force main and the standpipe is $500,000, and the contracts call for completion of the work on or before November 1, 1907.



Section Through Warehouse.

The value of this new water supply to Lockport can hardly fail to have an important effect upon the future of that city. This is, of course, more or less true of any place, but the relative importance of the quantity, quality and reliability of the source of supply in this case will no doubt furnish reasons for an impetus to the growth of this city in the heart of the Niagara electric zone.

Steam Losses Due to Drainage in a 200-h.-p. triple-expansion engine at Charlottenburg have been investigated by Prof. Josse. He found that the steam losses in five drainage vessels as a result of faulty closing amounted to, roughly, 5.8 per cent. of the total steam consumption, in spite of most careful attendance. The loss would naturally be much greater under ordinary working conditions.

The Storage Warehouse of the Fireproof Storage Co., Cleveland.

The storage building recently erected on Euclid Ave., Cleveland, O., for the Fireproof Storage Co. of that city is constructed of reinforced concrete with self-supporting shale-brick walls. It is 60 ft. wide by 130 ft. long and was the first six-story concrete building erected in the city as up to the time of signing the contracts the Cleveland Building Code limited all concrete structures to four stories. The contract was therefore let contingent upon the contractors procuring a permit for the six-story building. It was mainly through their efforts and those of the building inspector that the revision of the Code was started and later on an ordinance was passed allowing six-story concrete buildings to be erected. The structure was originally designed of steel fireproofed with concrete, but as the owners were partial to reinforced concrete and its cost was lower, they turned over the design and erection of the building entirely to the contractors, who have made a specialty of such work.

The first floor was designed to resist a live load of 200 lb. per sq. ft., and all the other floors 125 lb. per sq. ft. The floors were divided into panels 18 ft. 11 in. by 18 ft. 6 in. span, supported on columns with girders 18 ft. 11 in. span crossways of building, and beams 18 ft. 6 in. span and 6 ft. 8 in. apart on centers. The typical floor slab was 4 in. thick and reinforced with ⅜-in. rods 7 in. apart on centers across the beams and ¼ in. distributing rods 12 in. apart on centers lengthwise of the beams.

The typical beams were 18 in. deep by 6 in. wide on the bottom, tapering to 9 in. wide at the top and were reinforced with five 1-in. rods. Two of these rods were bent up following the curve of contraflexure and calculated to take care of the negative bending at the supports, as in designing the beams they were assumed as continuous over six supports. The girders were 20 in. deep by 8 in. wide on the bottom, tapering to 10 in. wide at the top, and were reinforced with five 1¼-in. rods, two of which were bent up as for the beams, although the girders were not considered as continuous.

The columns were built of square section with the corners beveled 2 in. and reinforced with round rods sufficient in size to take care of the entire superimposed loads. The concrete was considered to resist all the dead load. A plate of sufficient size to reduce the pressure to 350 lb. per sq. in. was set in a cement mortar bed directly on top of footing. These plates were ⅝ in. thick in all cases. All the rods used in reinforcing the columns had milled ends. The lower end of the rods from the basement to the first floor rested on top of plates, and all top connections were made with pipe splices 2 in. below the top of floor slabs. The concrete outside of the column rods was considered only as fireproofing. The stories above the first floor were all 9 ft. 8 in. high in the clear below the floor slabs.

The stairways for the building were of reinforced concrete 5 ft. wide with 6x33-in. concrete balustrades reinforced to carry the stairs. The stairways were built in after the completion of all the floors and are really independent of the rest of the structure. They are designed for 150 lb. per sq. ft.

The basement of the building extends out under the sidewalk and is floored over with a reinforced concrete slab designed to resist a superimposed load of 300 lb. per sq. ft. This also is independent of the rest of the building. The slab is 6 in. thick with 10-ft. span.

The concrete mixture for the entire building, except foundation walls, was composed of 1 part Portland cement, 2 parts bank sand and 4 parts of 1-in. crushed slag. A portion of first floor, however, about 50 ft. square deserves particular mention as it was made of concrete composed of slag varying in size from ¼ in. to 4 in., this material being left over from footings. A section of this floor was severely tested and did not develop any signs of weakness. A load of 34,000 lb. was placed on a section 7 ft. wide by 9 ft. long over the center of a typical beam, this load being equal to a superimposed load of three times the estimated live load. Loads of 3,600 lb. were evenly distributed over the area tested at intervals of one-half hour until half the total load was on. It was then allowed to set over night and finally completed in the same manner the following morning. The ultimate deflection was less than 5/64 in. A clear idea of the effect of loading can be seen in the accompanying deflection diagram. Special attention is called to the set of the beam over night and also to the small amount of deflection for the first load added on the following morning. After the load was allowed to set for several hours it was taken off in the same order as it was applied.

All the steel reinforcing consisted of round rods of 80,000 to 90,000 lb. tensile strength, built up at the building according to the Carey system of reinforcing.

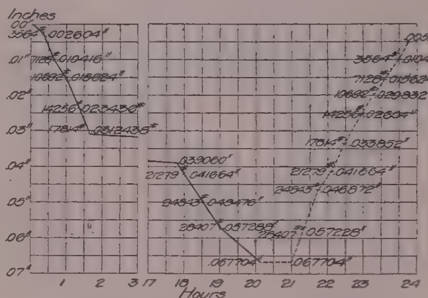
After the final completion of all floor and roof slabs and after the forms had been removed, a 1-in. cement finish, troweled smooth and blind-jointed every 48 sq. ft., was put down on top of the concrete base of the floors for the entire building, except in the packing room and office on the first floor. This section was covered with ⅞-in. factory maple, laid on 2x4-in. sleepers bedded in cement. With the exception of the office fixtures this was the only wood used in the entire building.

The centering employed was unusual. For the floor slabs panels were built up so as to support not only the floor but also the sides of the beams and girders. The bottoms of beams and girders were formed by a plate wide enough to support these panels. With this method it was possible to remove the floor supports and the side boards for the girders and beams without removing any shores under the beams and girders. After a little experience it proved to be very satisfactory, although it was found, from the cost sheets of the work, that the first cost of making such panels is too great to warrant the use of them for a building of only six stories, unless they could be used in another building. At the completion of this building the panels were practically as good as new.

The area of each floor was 7,800 sq. ft. and the time required to remove one set of panels, center up and run the concrete for the next floor was ten working days. However, the actual time required to run the concrete for the six floors and roof was eighty working days, using a gang of twenty men, including carpenters, laborers and men for laying steel. The time stated for running concrete also includes the laying up of brick walls. The day after the concrete was completed for a floor, the bricklayers were at work on the walls for the next floor, and by the time the forms were all up and steel placed, the walls would be ready on one side of the building, and by the time the concreting for the floor was completed the bricklayers would be through with the walls. In this way there was no lost time for either gang.

The building is mainly lighted by electricity, as there are very few windows in it. There are none on the sides, and only four on each end of each floor. They are of wire glass set in metal sash and frames, and have automatic closing devices for fire protection. All the exterior doors are of metal with metal frames. The wiring is all in conduits bedded in the floor set at the time of running the concrete slabs, so that there can be no danger of fire from this source. The electricity for lighting and running elevators is generated in the basement of the building, and the building is also equipped with its own heating plant.

The first floor is used as a packing room and offices. All floors above the first are divided into compartments of various sizes, sided up from floor to ceiling with metal stud and lath partitions and plastered on both sides with fireproof plaster. The front of each compartment is fitted with a Wilson fireproof rolling iron door. The compartments are sufficient in size to store all the furniture, except pianos, for an average size house, and the building has a capacity for storing the household goods of nearly one thousand homes. The doors for all compartments are always kept closed except when storing or removing furniture. It is considered impossible for fire to get from one room to another. On the second floor is a large piano room where all pianos are kept. On the first floor adjoining the office is a fireproof vault 16x36 ft. for storing silver and valuables. The building is plastered from top to bottom and presents a very clean and neat appearance, so often missing in other buildings of this kind.



Load-Deformation Diagram.

Loading of Floor Panel of Warehouse.

The structural features of the building were designed and erected under the direction of W. S. Ferguson, chief engineer of the Carey Construction Co., the general contractors for the building, and the other requirements for the building were planned by H. J. Latimer, general manager of the Fireproof Storage Co.

The Total Expenditure for Canadian canals has been $111,600,000. Of this sum $89,000,000 have been spent since 1867. The total revenue until 1905, when all tolls were abolished, was $13,400,000.

The Protection of Trade Secrets.

The protection of trade secrets by law, a subject recently discussed at some length in these pages, is again brought to attention by a decision of the New Jersey Court of Chancery in the case of the Taylor Iron & Steel Co. v. Nichols. The Taylor Company, under a license from R. A. Hadfield, the well-known British metallurgist, undertook the manufacture of manganese steel a number of years ago. For about nine months after the process was first tried it was under the direction of a skilled superintendent sent from England. After that time, however, the company claims that it introduced many new methods in the manufacture of the steel, not known to Mr. Hadfield, nor disclosed in his patents, and that these methods and processes were essentially trade secrets. Some time prior to the discovery of most of these improvements the defendant in the case was engaged by the company as its assistant superintendent. On entering its employ he signed a long agreement stating in substance that he would remain in its employ for a specified time and would not divulge to any person any information of any nature then known to him or which he might thereafter acquire relating to any of the steel processes that might have been or might thereafter be used in the works of the company. The agreement was so drawn up that the secrets governing the Hadfield process were to be considered confidential only until the expiration of the life of the Hadfield patents. The defendant subsequently left the company's service and entered that of a rival corporation, and the Taylor Company brought suit against him for an injunction to prevent his imparting to his new employers the trade secrets learned in its employ. The decision of the court, 65 Atl. Rep. 695, is a long document, but the most important part of it can be summed up substantially as follows: "A manufacturer of steel used secret methods in his business which yielded an improved product and engaged an employe who contracted to serve for five years and who agreed not to divulge any of the secret processes. A competitor induced the employe to break his contract of employment and to enter into a contract of employment with him. The first manufacturer was entitled to an injunction restraining the employe from disclosing the secret processes, and to restrain the competitor from using information acquired from the employe, and from continuing him in his employ."

An Experience with Clogged Sewage Beds at Pawtucket, R. I.

The Board of Public Works of Pawtucket and the State Board of Health of Rhode Island have now been co-operating for many years in the study of sewage purification problems. The investigations carried on by Mr. George A. Carpenter, city engineer of Pawtucket, and the State Board have been productive of a number of interesting results, one of which, relating to the clogging of sewage beds, is explained in a recent bulletin issued by the State Board, from which the following notes have been taken.

The history of sewage purification in Pawtucket has been similar to that in other places, in the same latitude, using sand filtration. Those beds which have shown high nitrification during the warmer months of the summer have shown a decreased nitrification as cold weather approached, and at times, while giving an effluent of fairly good appearance, still have shown practically no nitrification, but as soon as warmer weather came on, returned to their normal condition. The winter of 1905-06 was a mild one and the Pawtucket beds maintained nitrification longer than in some winters; but instead of all the beds recovering from the effects of the winter, they continued to give poor nitrification and would stand with sewage on them not merely for hours, but for days before one could see the surface of the sand. Attention being called to this condition by City Engineer Carpenter, and the analyses indicating, as above stated, a poor nitrification, special work on the plant was begun, co-operating with the city engineer, to rectify the trouble if possible.

Examinations of sand in the beds for albuminoid ammonia showed a large accumulation of nitrogenous matter in the upper layers, the top 8 in. of most of the beds showing quite high figures; and a tabulation of the strength of the sewage of other winters and summers showed that the winter of 1905-06 had given a very much stronger sewage than any previous period. It was assumed that this strong sewage, through the winter just passed had clogged the beds in addition to the stored nitrogen of previous years, and that a removal of 6 to 8 in. of sand and resurfacing with new sand might correct the difficulties.

Breaking Through Growth to Permit Drainage.

Growth Curling Up on Filter Beds.

Accordingly the sand in two beds was removed to a depth of 6 in. and new sand put on, the under drainage system having been previously cleaned. At first, after nitrification had been established, conditions were quite a little better, but very soon these beds again showed a marked decrease in nitrification, finally reaching the point where little or none was obtained, and the surface of the beds soon presented the now familiar appearance of a large greenish black deposit spread over the entire surface of the bed. This deposit had the appearance and consistency of a rubber mat, and was very tough, and impervious to water. After collecting on the beds it curled up when dry, in great quantities, as shown by an accompanying illustration. This necessitated very frequent scrapings in order to have the beds perform any work, for if it was allowed to remain there too long the whole bed became clogged and sewage stood on it to the depth of several inches, and it became necessary to put men onto the beds with spades to break through the deposit and open up the top of the sand and allow the sewage to work away through the beds.

An examination of this black deposit showed it to be made up to a great extent of Oscillaria. It was now thought that the trouble might be due to this growth on the beds, and that if it were possible to kill this the conditions would improve. On Aug. 6, 1906, two beds were treated with 2 lb. of copper sulphate to each bed, the area of each bed being about 0.18 acre. The copper salt was trailed through the sewage, which was held on the beds to a depth of approximately 6 in., the outlet to the underdrains being closed. After this copper was all dissolved the beds were allowed to stand for about 48 hours. The sewage was then drained off through the bed and the operation repeated. At first it seemed as if the trouble had been somewhat relieved by this treatment, but very shortly the growth returned.

Realizing from albuminoid ammonia tests that the beds contained too much stored nitrogen for them to do the best work under any conditions, several other beds were scraped to a depth of 8 in. and resurfaced with new sand, but the experience with these beds was similar to that with the two which had been used for experimental purposes.

During all this time, as has been the custom for a number of years, the sewage had been applied to the beds at the rate of 100,000 gal. per acre, and the dosing being on alternate days was at the rate of from 50,000 to 60,000 gal. per acre per day. Thinking that this rate of dosing was probably too much for the beds considering the quantity and strength of the sewage, the dose was dropped to 25,000 gal. per acre per day on two of the beds which had been resurfaced, and a very satisfactory nitrification was established, but the growth of Oscillaria which had been present in the plant finally appeared on the beds again, although not to the same extent as previously.

A careful and thorough investigation of all the conditions at the plant, especially of the distributing system, showed the presence of a very large growth of Oscillaria together with some Ulothrix and Cladaphora in the main distributor to the beds and the manholes. This fact indicated that possibly the Oscillaria and other growths had been killed in the copper sulphate experiment, but the spores of the organisms had been carried from the distributor, through the conveyors, onto the beds, there to flourish and clog the surface again. No signs of these growths were found in the screen tanks, or settling tanks, so the problem now seemed to be to clean up the main distributor. Accordingly at the suggestion of the chemist of the board, Mr. Gilbert H. Pratt, who had also suggested the earlier copper sulphate experiment, this main distributor and the manholes were thoroughly scoured with steel brushes and then scrubbed with a solution of one part copper sulphate in 5,000 parts water. After this cleaning all sewage flowing onto the beds was dosed, just as it left the settling tank, with copper sulphate, one part in 50,000, for a period of fifteen days. At the end of this time the method of operation of the plant was as before. The use of the copper solution was discontinued and the rate of dosing on some beds now being 50,000 gal. per acre per day, and on other beds 25,000 gal. per acre per day.

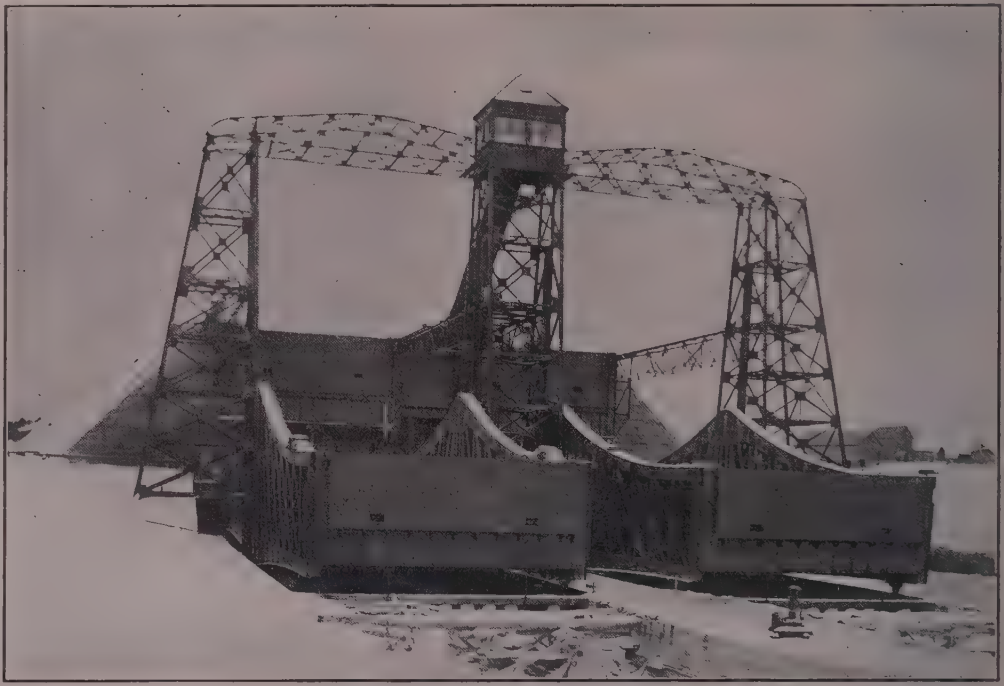
The nitrification of the plant was not injured in the slightest degree by the copper sulphate treatment; on the contrary the general condition in that respect, at the end of fifteen days, was better than at the beginning, and after the plant had returned to its normal condition as to treatment, nitrification kept increasing and continues high up to the present time, January, 1907, when, judging from the experience of former years, one would not be surprised to have a low nitrification. The beds are now giving good results and effluents of good appearance, and the Oscillaria and other growths have ceased. Since the dosing of the sewage flow with copper sulphate there has been no delay in drying out the beds and the deposits on the beds have been normal in quantity and in appearance.

The only sign which has been seen of these growths has been in a location which furnishes a strong argument for the results which have been accomplished by the use of the copper sulphate. Some of the beds were furrowed when this dosing took place. This has been the custom in other years as fall approached. This was the case with the worst bed, from the standpoint of microscopic growths. A very marked green growth made its appearance on the top of the furrows on this bed above the "high water line" and remained for some little time, but finally disappeared and did not spread to any great extent into the bed. The same phenomenon was noticed on one or two of the other beds, which had not been furrowed, the growth showing on the banks at the edge of the grass just above where the dosed sewage reached.

As explaining why these small growths which appeared did not spread into the bed more, it is suggested by the chemist that the accumulated copper in the top layers of the bed may have exerted a strong enough toxic effect to have prevented this. This suggestion is in line with some experimental work carried on under the direction of the Massachusetts State Board of Health on the storage of copper in the sand of water filters, which showed that there was a very decided accumulation of copper in the top few inches of the sand of filters which had been treated with water containing copper sulphate.

To sum up the situation, drawing conclusions from points brought out in these remarks and from analyses which have not been presented here, one may conclude as follows: The sewage of Pawtucket, which, when screened and settled for a period of about four hours, contains normally in parts per 100,000 about one part of albuminoid ammonia, about 10 parts of free ammonia and about 20 parts of suspended solids, and about ten parts oxygen consumed by the five-minute boiling test, had increased in strength and quantity during the winter of 1905-06 to such an extent that the limited filtering area and heavy dosing clogged the beds with stored nitrogen and fatty matters so that when the spores of the micro-organisms were carried onto the beds from the main distributor the conditions were most favorable for the production of a network which these growths soon formed. Had the beds been able to dry out quickly, the growth would probably not have secured such a hold on the beds as they did. Thus the strength of the sewage and the dose were the primary cause of the trouble. The micro-organisms may be regarded as the secondary and most crippling cause, for it was these that finally put the beds almost out of commission. Resurfacing the beds and watching the rate of dosing no doubt helped matters, but the main relief was obtained from cleaning the distributor with copper sulphate and the subsequent dosing of the sewage with the same. This is emphasized by the fact that beds that were not resurfaced improved greatly after the copper sulphate treatment, with no material change in rate. A return of the bad conditions may be looked for, however, at any future time if extreme care is not exercised in the rate of dosing of the beds and changes made in the rates at which sewage is applied to the different beds when their action calls for lowering the rate.

At Pawtucket this careful oversight has been provided by the assignment of a special assistant engineer to keep in close touch with the plant and all conditions existing there as to quantity and strength of sewage and condition of the beds, and to give instructions as to the rates at which sewage should be applied to the different beds. Since this assignment there have been several instances where a change in rate at the proper time gave improvement in the drying out of the bed and in the quality of the effluent. This should be borne in mind in connection with other plants, for a plant which would purify the sewage of a community several years ago cannot necessarily do it satisfactorily to-day with the same supervision, as the increased quantity and strength of the sewage on account of the natural increase in population may overtax the capacity of the plant as at Pawtucket.



Kirkfield Lock Almost Completed.

Construction of Chambers, Kirkfield, Lock.

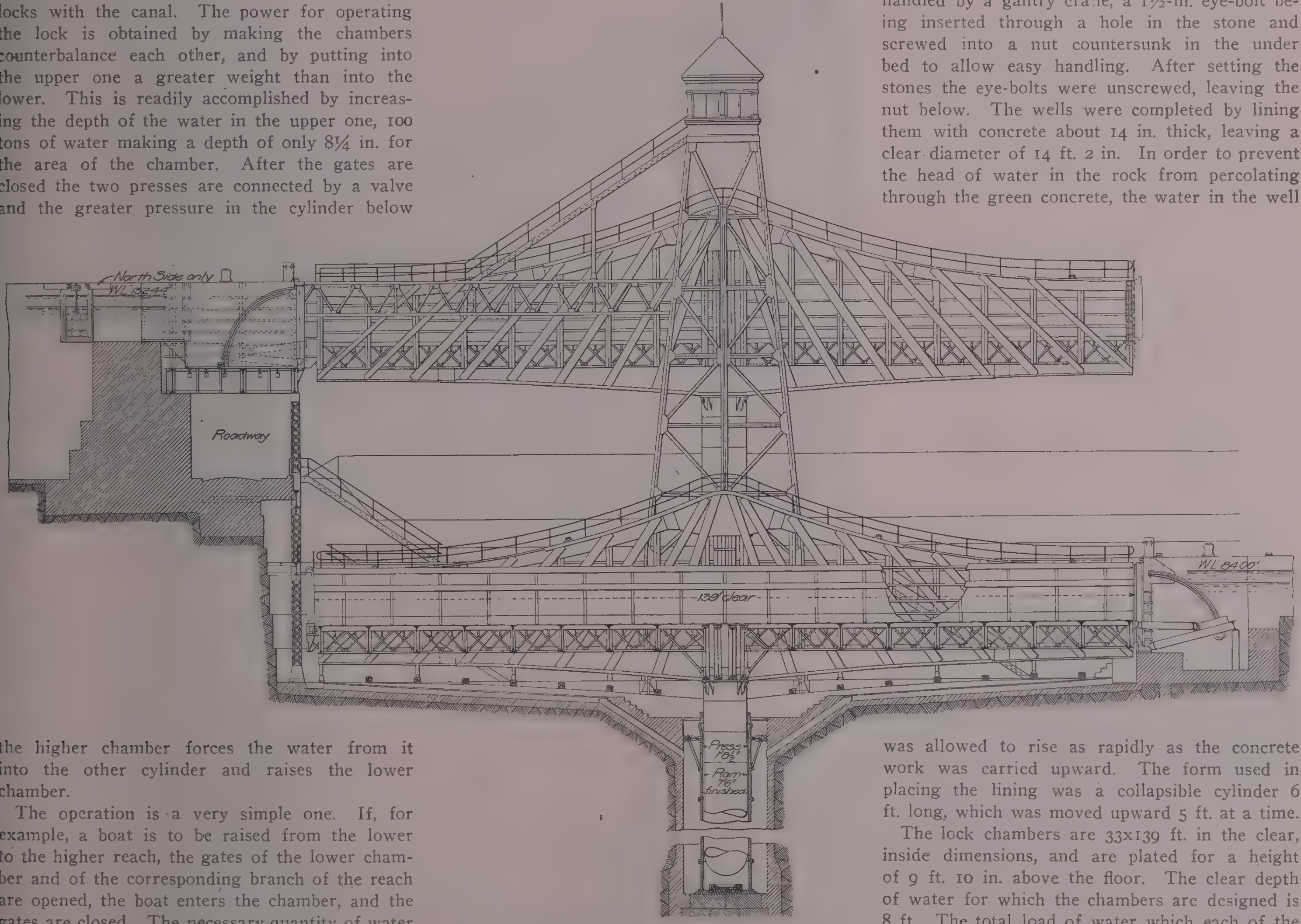
This plant is now giving good results under unfavorable conditions as to season, while before the copper treatment, under the most favorable conditions of summer and early fall, the results were so poor that the plant was nearly out of commission at times. It is felt that these experiences may serve as a precedent for similar treatment with copper sulphate at some other place, or again at Pawtucket, if micro-organisms make their appearance, provided, of course, that this treatment be made with properly calculated doses and under expert supervision.

A 40-Ton Hydraulic Coal Transfer Hoist has recently been installed on the new docks of the Northeastern Railway at Middlesborough, England, for the transfer of coal from railway cars to vessels by lifting a large receiving hopper into which the coal is dumped from the cars, to an elevated position and chuting from thence into the vessels. It consists of a massive steel framework with hoisting gear for lifting a cradle, 28¾ ft. long by 19 ft. wide, to a maximum height of 85 ft., and an overhanging delivery chute which may be adjusted to any height to accommodate any type of vessel being loaded. The cradle carries a line of railway track and underneath it a coal receiving hopper of 40 tons capacity, so that when lowered to a position level with the dock cars of coal may be run onto it and dumped into the hopper. When the hopper is filled the cradle is hoisted and the coal delivered through the overhanging chute to the vessel alongside. The flow of coal from the chute is governed by a gate at the lower end, to facilitate trimming. As the chute is enclosed, it forms a receptacle of sufficient capacity to receive a full hopper load, thus permitting the cradle hopper to be dumped at once and descend for another load. The hoist is capable of transferring considerably more than 400 tons per hour.

The Kirkfield Hydraulic Lift Lock.

The hydraulic lift lock at Kirkfield, Ontario, on the Trent Canal, between Balsam Lake and Lake Simcoe, is practically completed, and will be thrown open to navigation on May 1 of the present year. This will be the fifth lock of this type in operation, there being three in Europe and one at Peterborough, Ontario. The latter, which has already been described in The Engineering Record, has the same dimensions as the Kirkfield lock, but has a lift of 65 ft., as against 48.44 ft. at Kirkfield.

The lock consists of a pair of chambers mounted on the pistons of two hydraulic presses. The chambers are closed by means of gates at both ends, which can be opened so as to connect the locks with the canal. The power for operating the lock is obtained by making the chambers counterbalance each other, and by putting into the upper one a greater weight than into the lower. This is readily accomplished by increasing the depth of the water in the upper one, 100 tons of water making a depth of only 8¼ in. for the area of the chamber. After the gates are closed the two presses are connected by a valve and the greater pressure in the cylinder below the higher chamber forces the water from it into the other cylinder and raises the lower chamber.



Section Through One of the Chambers.

The operation is a very simple one. If, for example, a boat is to be raised from the lower to the higher reach, the gates of the lower chamber and of the corresponding branch of the reach are opened, the boat enters the chamber, and the gates are closed. The necessary quantity of water to counteract the weight of the lower chamber, its contents of water and vessel, and the friction on the guides, is put into the upper chamber, the valve connecting the presses is opened, and the lower chamber ascends while the upper one descends. When the elevations of the reaches are obtained, the chambers stop, the upper one is connected with the upper reach by opening the proper gates and the vessel proceeds on its way. The entire operation takes but a short time, the record lockage at the Peterborough lock, already referred to, being 6½ min. from the time of stopping the vessel in the lower reach to her starting under her own steam in the upper one.

The chambers, towers, gates and aqueduct are of steel, the retaining walls, breast wall, abutments and foundations of concrete. The breast wall is normal to the axis of the canal, and terminates the upper reach. At a distance of 650 ft. from this wall the canal begins to widen from its normal width of 50 ft. At the breast wall it is 88½ ft. wide and is divided into two channels by a center concrete pier 24 ft. 5 in. wide. The upper approach of the lock for a distance of 1,050 ft. consists of concrete side walls, and a concrete-floored bottom. The breast wall is 22 ft. 9¾ in. wide at the base and 16 ft. 9¾ in. wide at the top, 40.44 ft. above the elevation of the water in the lower reach of the canal. The elevation of the top of the center pier and of the side retaining walls is 10 ft. higher. Heavy rip-rap backing was placed against the retaining walls. Inside the breast wall and parallel to its length runs a chamber where the pressure pumps for operating the lock are located. A drainage channel with a valve is provided through the north retaining wall, for emptying the upper reach into culverts discharging into the adjoining Talbot River. The foundations rest on the solid rock, which was found near the surface. The excavations for them included 4,500 cu. yd. of earth, and 7,000 cu. yd. of rock. There are 25,200 cu. yd. of concrete. The forms were made very carefully, the facing being of 3-in. plank with rabbetted joints.

Connected with the front of the breast wall are two steel channels called aqueducts, which connect the branches of the upper reach with the chambers. Their length is 24 ft. and the clear depth 8 ft., the bottom being at the same elevation as the top of the breast wall. One end rests on a seat in the breast wall and the other end on steel columns which run down to foundations in the pit beneath the chambers. A roadway and footwalk cross the canal beneath the aqueduct, as shown in one of the pictures.

The lock pit, 170 ft. long and 40 ft. deep, adjoining the breast wall on the lower reach side, is excavated in solid rock. The sides were cut with a channeling machine and the machine-cut face left without covering. The construction of the pit required the excavation of 25,750 cu. yd. of rock and 3,000 cu. yd. of earth, and the placing of 4,600 cu. yd. of concrete.

The press wells in which the hydraulic presses are mounted have an extreme depth of 64 ft. below the bottom of the lock pit. The rock excavation for them measured 16 ft. 6 in. in diameter. At the bottom a perfectly level bed was bush-hammered on the solid rock, and a granite foundation of three courses was carefully laid up. On account of the total load of the chambers coming on these foundations each stone was carefully dressed, the courses well bonded, and all joints limited to a thickness of 5/16 in. The mortar used was composed of 3 parts of Portland cement and 1 of sharp sand. The stones were handled by a gantry crane, a 1½-in. eye-bolt being inserted through a hole in the stone and screwed into a nut countersunk in the under bed to allow easy handling. After setting the stones the eye-bolts were unscrewed, leaving the nut below. The wells were completed by lining them with concrete about 14 in. thick, leaving a clear diameter of 14 ft. 2 in. In order to prevent the head of water in the rock from percolating through the green concrete, the water in the well was allowed to rise as rapidly as the concrete work was carried upward. The form used in placing the lining was a collapsible cylinder 6 ft. long, which was moved upward 5 ft. at a time.

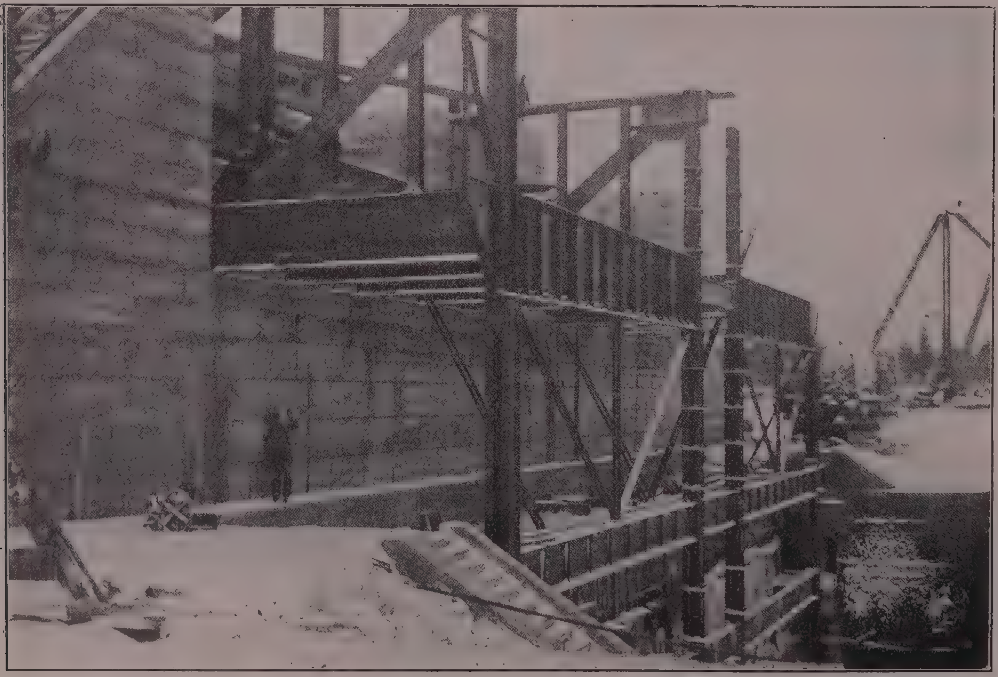
The lock chambers are 33x139 ft. in the clear, inside dimensions, and are plated for a height of 9 ft. 10 in. above the floor. The clear depth of water for which the chambers are designed is 8 ft. The total load of water which each of the lock chambers holds is 1,700 tons, and since a floating vessel displaces its own weight of water this is the maximum load that will be handled. Double cantilever trusses 32 ft. deep in the center, on each side of the chambers carry the load to the top of the pistons. It is not necessary to provide for any alternate stresses, since the load is always similarly placed. All the truss connections are riveted. The top chord cover plate is 30 in. wide. Universal mill plates are used for diagonals. The plating of the floor is ⅜ in. thick, and on the sides 5/16 in. thick, with riveted butt joints, with both edges calked. The floor system is very heavy and the load is brought on top of the pistons through four girders 9 ft. deep. Slides are attached at the center to the outside of the upper and lower chords and engage guides in the towers, so as to maintain the chambers in their upright position. There are three steel towers, one on the center pier dividing the lock chambers and one on each bank of the canal. Steel bridges span the lock chambers connecting the towers and have their lower chord 73.44 ft.

above the water level in the lower reach. These bridges allow a clearance of 25 ft. above the water level of the chambers when the latter are raised to their greatest height with full depth of water. On top of the central tower is the lockmaster's cabin, from which the lock is operated by a system of interlocked levers.

The pistons or rams of the hydraulic presses are 7½ ft. in diameter, working in cylinders 7 ft. 8½ in. in diameter. The full working stroke corresponding with the total lift of the lock is 48.44 ft. The pistons are of cast iron 3¼ in. thick, built in sections 5 ft. 3 in. long, and bolted together with forty 1¼-in. bolts. The joints are rabbeted and tongued, and filled with a gasket of pure copper 1/10 in. thick and ¾ in. wide. The gasket is inserted flat and when the bolts are drawn up tight the copper conforms with the rabbet and gives a water-tight joint. The press cylinders are made of steel castings 3½ in. thick and built up in the same manner as the pistons, except that a lead gasket is used in a V-shaped groove in addition to the copper gasket. Fifty-six bolts, 1⅝ in. in diameter, were used in the cylinder joints. All the sections of both pistons and cylinders are tested before insertion in the work under a pressure of 1,200 lb. per sq. in., which is double the working pressure.

The top of each press is fitted with a stuffing box, 1 in. wide and 10 in. deep, packed with rings of braided hemp and tallow packing, which is tightened by a steel gland held in place by 36 bolts. The presses are braced against the sides of the wells with adjustable struts which allowed accurate centering before the erection of the lock chambers was begun. The erection of the plungers was accomplished by a very simple and convenient method. After the completion of the press cylinder it was filled to the top with water and the discharge opening closed. The base of the plunger was then lowered by means of a derrick into the cylinder. The packing was at once placed, the gland screwed down and when the derrick hooks were removed the base was supported on the water confined in the cylinder. The next plunger section was then placed on the base and after the joint between the two sections was finished water was permitted to escape from the cylinder until the top of the section had sunk nearly to the top of the stuffing box. In this manner the whole plunger was successfully erected.

Erection of Fixed Deck Span, Havre de Grace Bridge.



Breast Wall and Aqueduct Steelwork, Roadway Under Girders.

The ends of the chambers and of the reaches are closed with water-tight gates operated by hydraulic cylinders. The gates are hinged at their lower ends and rendered practically buoyant by galvanized-iron air tanks. They are built of steel with vertical I-beam posts connecting with a girder which allows the stresses to be computed readily and properly cared for. The plating is on the outer side of the gates, and is 5/16 in. thick in the upper part and ⅜ in. below, with joints riveted and calked like those of the chamber plating. Each pair of gates, one on the chamber and one on the reach, operate in connection with each other and engage automatically. The gates are operated by means of a high-pressure water cylinder. The latter falls to the inside of the reach and the chamber gate folds over it away from the chamber. A recess is provided for the gates when open so as to allow the use of the full depth of the chamber.

The gates are made water-tight by a ½x2½-in. flap of rubber fastened so as to close over the joint between the frame and gate, and allow the water pressure to keep it pressed tightly against the metal. The space between the end of the chamber and the frame of the reach gates is about 2 in. wide and can be filled by inflating a collapsible rubber tube, which is attached to the frame of the reach. When it is desired to place the chamber and the reach in communication, the tube is inflated with air at a pressure of 10 lb. per sq. in., and effects a water-tight joint.

The power for operating the gate cylinders and supplying water to the presses is furnished by intensifier pumps operated by the head of water, about 48 ft., due to the difference in level of the two reaches. The engine end of the pumps consists of a double-acting water cylinder 40 in. in diameter. The piston of this cylinder is placed midway of the length of the 6-in. piston rod, the ends of which form the pump plungers. The stroke is 24 in. and the capacity of each pump 60 gal. per minute. The data in this article relating to the concrete work were furnished by Mr. A. J. Grant, superintending engineer of the Trent Canal, and the rest of the data appeared in a paper by Mr. W. J. Francis, before the Canadian Society of Civil Engineers. The contractor for the iron and steel work was the Dominion Bridge Co., Ltd., Montreal, and for all the other work Messrs. Larkin & Sangster, St. Catherines, Ont.

The Coal Fields at Batan in the Philippines promise to be very valuable according to the data gathered by the Mining Bureau of the insular government. Both lignite and bituminous coals have been mined, and thorough tests by government transports and launches show both to be of good steaming quality. In one square mile that was investigated it is estimated that there are 15,360,000 tons capable of being mined without any special difficulty. The seams vary in thickness from 18 in. to 10 ft., and entries may be made with ease at many points. The measures are along the shore of a perfectly protected harbor, where vessels could be loaded at all seasons without danger from storms. Timber of all kinds in any quantity is at hand. As a whole, everything seems favorable to the establishment of an economical mining plant.

Erection of Havre de Grace Bridge.

The Philadelphia, Baltimore & Washington R. R. of the Pennsylvania system crosses the Susquehanna River between Perryville and Havre de Grace, Md., on a double-track steel deck bridge about 4,154 ft. long, of which an illustration was printed in this journal on March 9. It weighs about 10,000 tons and contains one 280-ft. through riveted truss swing span and seventeen pin-connected Pratt deck spans 196½ to 255 ft. in length. The bridge is parallel to and about 150 ft. distant from the old iron bridge at this place and crosses the river at a point where a bar about 5 ft. below the surface of the water divides it into two channels with maximum depths of about 25 ft. and 50 ft. The deck spans have trusses 19½ ft. apart on centers and are divided into maximum panel lengths of about 28½ ft. The top chords are 36 in. deep and have three webs, one of them nearly under the outside track rail. The floorbeams, 60 in. deep, are connected to the tops of the vertical posts by 36 field-driven rivets in each end. All trusses have an odd number of panels with unadjustable diagonals in the center panels. The 196½-ft. span weighs 840,000 lb., and the 255-ft. spans each weigh 1,400,000 lb. The trusses of the swing span are 29½ ft. apart and 42 ft. deep at the center and are carried on a pair of twin transverse plate girders suspended from the center-bearing pivot.

About one-half of the superstructure was fabricated and erected by the Pennsylvania Steel Co., and the other half by the American Bridge Co. The latter company unloaded the members of the superstructure with derricks in a storage yard about a quarter of a mile north of the bridge. During the erection, the material was reloaded by the derricks on ordinary flat cars drawn by small locomotives from the yard to the bridge site, as required in assembling the parts of the structure.

The bridge was erected on pile falsework with the caps and stringers set directly on top of the piles without the intervention of any framed bents the top of the falsework being less 20 ft. above the surface of the water. Where the water was deepest, the pile bents were very heavy, and extra light loads were put on each pile on account of the great lengths necessarily left unbraced. Every other pair of pile bents were X-braced longitudinally above the surface of the water, thus forming alternate towers and open panels. To expedite the erection, the falsework was constructed simultaneously for several spans, instead of driving the bents for one or two spans and then pulling and redriving for succeeding spans, as is often done.

The falsework for the nine fixed spans required 175,000 ft. b.m. of timber besides 576 piles from 50 to 70 ft. long, which were driven to a penetration of 25 ft., except in two spans where the water was deepest and a penetration of 20 ft. was accepted. The falsework was proportioned throughout for a maximum concentrated live load of 35,000 lb. at one corner of the traveler; for the 192-ft. spans it was also proportioned for dead loads of 45,000 lb. and of 24,000 lb. at panel point, due to the steel superstructure and to the running out of materials respectively, and in the 255-ft. spans the corresponding loads are 79,000 lb. and 35,000.

The shore end span falsework bents were seated on framed sills and did not have pile supports. Each bent had one 12x12-in. vertical post in the plane of each 19½ ft. apart and two 12x12-in. vertical posts 5 ft. 4 in. shorter than these spaced 30 ft. 6 in. apart to carry the outer ends of short caps supporting the traveler tracks 29 ft. apart. The inner ends of these caps were supported on single full-length 6x8-in. vertical cleats spiked to the outside of the main vertical posts which carry the trusses. The difference in the height of the main and the outside vertical posts was due to the difference in the depth of the short span and the adjacent span and the necessity of keeping the traveler track at a uniform level from end to end of the bridge.

In four of the eight 255-ft. spans the falsework bents were made with 6 piles each, vertical piles were spaced 8 ft. and 11½ ft. each side of the axis of the bridge and the end piles of each bent, battered 1:6, 15 ft. each side of the axis at the top. Each bent had a 12x12-in. cap and one 6x8-in. horizontal transverse strut just above low water level, the panel between them being X-braced with single 4x8-in. timbers. The caps were secured to the piles with double steel scabs and all intersections of piles and braces were bolted. The falsework bents for the remaining four spans were each made with two additional vertical posts and with double 12x12-in. cap timbers, 36 ft. long, one of them laid on top of the other and thus making a compound beam 12 in. thick and 24 in. deep. For the two spans where the water is deepest, two of these pile bents were placed together at each panel point of the structure.

Hoisting Engine Traveler.

There are in all ten lines of 12x16-in. stringers with their ends overlapping on the pile caps, two lines in the plane of each truss and three lines in the plane of each traveler track rail.

The swing span was erected on falsework bents seated on top of the pier. The bents were each made with four vertical and two battered 12x12-in. posts, about 37½ ft. high with single 12x12-in. cap and sill pieces 48 ft. long, each made with two pieces spliced at the center with a pair of 6x12-in. x6-ft. slab plates. Material for the swing span was delivered to the fender pier on a special falsework with bents 29½ ft. apart, each of which consisted of a framed upper story 40 ft. high with two vertical and two battered 12x12-in. posts seated on the top of a 6-pile bent. The tops of the framed bents carried four lines of 15-in. I-beams, two lines under each rail of the service track. The three-bent traveler had horizontal and vertical clearances of 29 ft. and 51 ft. respectively and carried on its upper transverse trusses a stiff-leg derrick with a 10x12-in. wooden boom 36 ft. long seated over one of the front vertical posts. The stiff legs were anchored at the top of the adjacent vertical posts with pin-connected riveted shoes and plates.

The deck spans were erected by a three-bent wooden gantry traveler running on tracks on the trestle bents outside the trusses at lower chord level. The upper parts of the traveler bents were made in the usual manner with Howe trusses which supported on their top chords three lines of wooden jigger beams from which the tackles were suspended. The traveler was operated by two four-drum hoisting engines, and in order to avoid changing the rigging these engines, instead of being carried on the traveler platform, were seated on an independent auxiliary traveler which consisted merely of a horizontal wooden platform mounted on trucks on the main traveler track. The traveler platform cantilevered beyond the faces of the falsework and was provided with derricks to facilitate the hoisting of supplies from boats below. During the erection of each successive span, the platform was permanently located just beyond the forward pier and moved one pier in advance as each span was completed and the next was commenced.

The sequence of erection was the same for each of the deck spans. The posts, floorbeams, stringers, main diagonals and a portion of the lower chord bars were put in position, panel by panel, by the traveler moving forward over the incomplete structure. As fast as the floorbeams and stringers were thus assembled, a service track was laid on them and material was brought out over it and delivered to the traveler, the incompleted span thus serving as upper story falsework or pony bents for delivering material. After the web members and floor system of the span were assembled, the traveler moved back to the beginning and completed the erection of the span by assembling and connecting the top chords, thus making two trips from end to end of each span. The traveler did not have sufficient clearance for the draw span and the latter was therefore erected by an inside boom traveler.

Preliminary construction work was commenced in 1903 and the new bridge was completed and put in service about July, 1906. The designs were made in accordance with the specifications and standards of the Pennsylvania R. R. Co., Mr. H. R. Leonard, engineer of bridges. The superstructure built by the American Bridge Co., was erected under the direction of Mr. H. F. Lofland, general manager of erection. A general description of both substructure and superstructure was published in The Engineering Record of April 28, 1906.

AN EXHAUST STEAM TURBINE of the Rateau type has recently been installed at the steel works of the International Harvester Co., in South Chicago. The exhaust steam from a reversible blooming mill is utilized in a turbine of 600 kw. rated capacity, directly connected to direct-current, 215-volt generators. The exhaust from the mill engine is intermittent, and the steam is accordingly taken through a regenerator, having a capacity sufficient to take care of intermissions of several minutes' duration in the running of the main engine. The steam passes from the regenerator into the turbines and afterward to a barometric condenser. In working, it is said, the pressure at the inlet of the turbine is atmospheric absolute, and at the outlet 28 in. vacuum. The main engine gives about twice the amount of steam needed by the turbine, and in order to avoid back pressure on it, a 24-in. relief valve exhausts directly into the atmosphere when the pressure has a tendency to increase. In case of shutting down the main engine for a considerable period, an automatic reducing valve allows the steam from the boilers to be utilized directly in the turbine. It is understood that the installation proves that in the exhaust of an average reversible blooming mill engine, there is enough available power to furnish from 1,000 to 1,500 kw., the only expense for utilizing it being the interest and depreciation on the investment and the condensing water. The installation was made by the Rateau Steam Regenerator Co., 215 Wabash Ave., Chicago. A description of the regenerative accumulator was printed in The Engineering Record of Nov. 9, 1901, while the general use of the Rateau turbine with exhaust steam was explained on April 23, 1904.

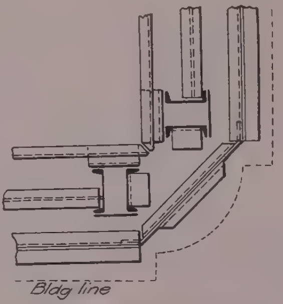
Structural Details in the Plaza Hotel, New York.

The new eighteen-story steel cage Plaza Hotel, facing the south end of Central Park, New York, has street fronts of 200 ft. on 59th St., 125 ft. on the Plaza and about 75 ft. on 58th St., the depth from 58th to 59th St. being about 250 ft. The building is somewhat irregular in plan, enclosing an interior square fully on two sides and partly on the third side, with wings about 50, 60 and 75 ft. in depth. The main interior light court is about 64x96 ft. and another 20x50 ft. is located in the long wing. The building covers an area of approximately 25,000 sq. ft. and has in its framework 201 main columns arranged with considerable regularity generally from 12 to 27 ft. apart in longitudinal and transverse rows. In the upper stories each of the three main wings is arranged with a central corridor parallel to the front or side wall and with rooms having exterior windows on both sides of it. The columns are, therefore, located principally in the walls of the corridors and in the exterior walls from about 12 to 23 ft. apart except in the corridors where they are only 6 or 8 ft. apart transversely. In the typical floors the beams and girders are in general single I-beams. The majority of the floorbeams are 12-in. I-beams 5 to 6 ft. apart. In some places double I-beams are used for the girders and 8-in. I-beams are used for the corridor floors. All floors are built with hollow tile, about 578,000 sq. ft. of which were furnished for this purpose by the National Fireproofing Co.

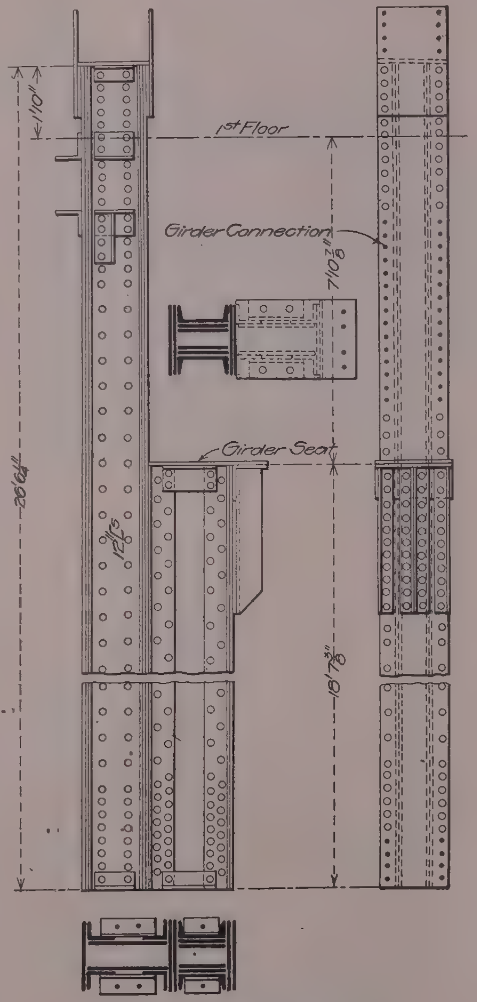
The construction of the lower tiers of the framework is special on account of the architectural features of the exterior and the requirements for the large unobstructed area for public rooms in the first story. The main entrance occupies the central panel of the building about 70 ft. wide and is provided at the second floor with a heavy cornice and balcony and supported by a row of massive stone columns just outside the building line and carrying a framework of steel channels and beams. At the 59th St. corners double columns are set close together to provide for the rounded surface of the wall masonry and are arranged as shown in the detail with the wall girders cut short of the building lines and connected across the corner by diagonal channels.

In order to provide large areas unobstructed for the public rooms in the first story and for the ball room in the second story, a number of columns in those stories have been omitted and those in the tiers above are carried by a system of heavy plate girders of which there are 63, weighing from 5 to 20 tons each, and aggregating 610 tons in the first story. In the second story there are fourteen 16-ton girders. Most of these girders are supported directly by the columns, but in some cases one end of a girder is carried by a second girder, thus involving some very heavy stresses. The second floor girders all have single webs 38, 44, 58, 64 and 70 in. in depth and varying from ⅜ to ¾ in. in thickness. The flanges are made with pairs of 6x4, 6x6 or 8x8-in. angles with and without cover plates. Most of the girders are used in pairs, but are structurally separate, except for transverse diaphragms.

The girder marked 1P119 is typical of the two girders in the first floor and is nearly symmetrical about the line AA, which is, however, a little beyond the center. The girder is 51 ft. 5 in. long over all and is made with a 70x¾-in. web plate in two lengths, shop spliced, as shown at AA. The splice is made with one 45x9/16-in. filler plate and four 13x½-in. cover plates, which also serve to reinforce the web together with the 6x6x½-in. vertical angles which provide for the shear from the column load above. Flanges are made with pairs of 8x8x1-in. full length angles and 12x9/16-in. full length vertical plates and have 18x¾-in. cover plates of different lengths, as shown in the elevation. The girders are arranged in pairs with the inner flanges cut to clear the columns and the webs field-riveted across the column faces, as indicated by the open holes shown in the drawing. The girders of each pair are connected by five transverse diaphragms made with 18x½-in. vertical plates and a pair of 4x4x⅜-in. angles field-bolted through the upper holes shown in the girder. A somewhat different girder, also in the first floor, is shown in the drawing marked 1P289. It is 51 ft. 8½ in. long and is made with a 70x11/16-in. web plate with two shop-spliced pieces. The full length 8x8x1-in. flange angles are reinforced by two 17x⅞-in. and two 17x¾-in. cover plates. This girder carries, near the center, two corridor columns 7½ ft. apart on centers for each of which web reinforcement is provided by six 6x3½x½-in. angles and filler plates. At one end the girder web is field-riveted across the face of the column and at the other end is seated on the top of a column extension provided to afford it horizontal bearing.



Corner Masonry Support.



Column for First Story Girder.

All columns have closed rectangular cross-sections made with channels and flange cover plates. In the upper stories the columns are composed of two channels and two cover plates. In the lower stories additional cover plates are required and web reinforcements for the channels, while in the basement the very heavy stresses require the sections to be increased by extra pairs of channels riveted together back to back with web reinforcement plates between them, as indicated in the details of column 2, which is made with four 13-in., 50-lb. channels, six 20x⅞-in. cover plates and three 12x¾-in. web reinforcement plates.

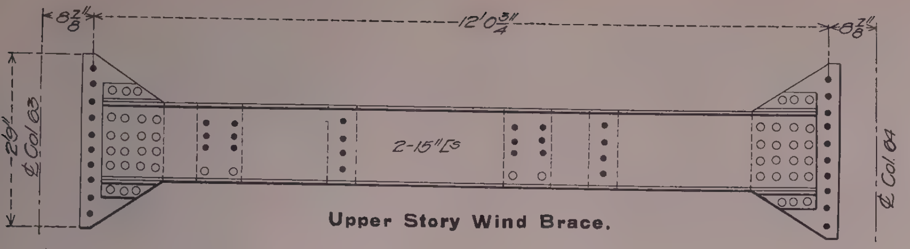
All beam connections are made with horizontal shelf angles riveted to the webs or flange cover plates and having their outstanding flanges reinforced by bearing on the upper ends of vertical distributing angles. Upper horizontal connection angles engage the top flanges of the beams and both upper and lower angles are generally 6x6x ½ in. and are shop-riveted to the columns. The beams are cut with small clearances between their ends and the cover plates of the columns and rivets in the latter are flattened when necessary to enable the beams to be moved transversely into position after the columns have been erected.

The columns are all made in two-story lengths with splices about 20 in. above the floor lines. Joints between successive sections are spliced with jaw plates shop-riveted to the lower sections and field-riveted to the upper sections and wherever the cross-section of the column changes contact is made between the adjacent ends through a horizontal diaphragm engaging short angles riveted to the column webs.

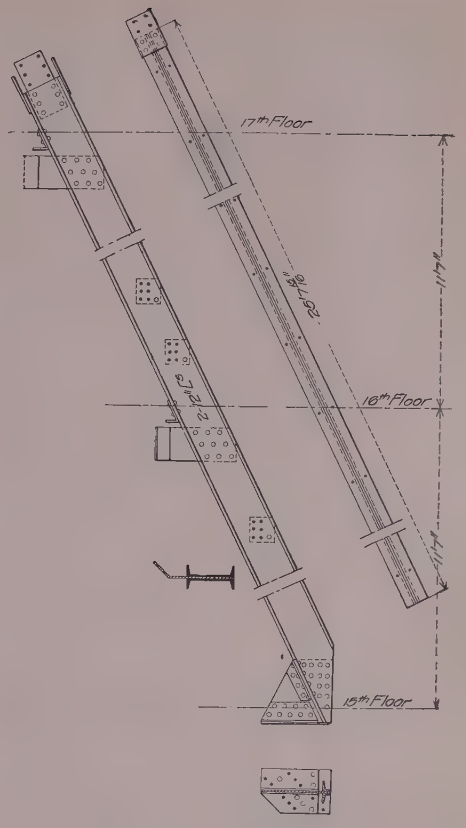
Some of the columns which support the second floor girders are made with extensions having horizontal caps for the seats of the girder flanges. This virtually results in a twin column, one side of which terminates at the girder bearing and the other side is spliced to the next upper section of the regular column. This construction is exemplified in the elevation of column 35. The lower section of this column about 34 ft. long extends through the basement and sub-basement stories and terminates with a ¾-in. cap plate on which the second section of the column is seated. The latter has at the lower end the same cross-section as in the basement and sub-basement. One side of the column, however, terminates about 8 ft. below the other side and is provided with a cap plate forming the horizontal seat for the box plate girder which is riveted through one web to the other column, open holes being left for the field-driven rivets as shown in the side elevation. By this means the weight of the heavy girder and its load is transmitted directly to the foundations and the weight of the upper stories is carried independently of it through the other half of the column. The side of the column which carries the girders is made with four 6x4x¾-in. angles, two 19x¾-in. web plates and one 16x⅝-in. side plate. The flanges on one side of the column are riveted directly to the two 16x13/16-in. cover plates on the adjacent side of the other half of the column which has in addition two more cover plates of the same dimensions, four 11x⅝-in. plates and two 12-in., 40-lb. channels.

Wind stresses computed for a horizontal pressure of 30 lb. per sq. ft., on the exposed surface of the vertical walls are provided for in the narrow wings by five sets of solid web knee braces, by three sets of detached knee braces and by three sets of diagonal braces, all extending from the basement to the fourteenth floor inclusive. The systems of solid web knee braces are applied to the panels between three adjacent columns excepting in one case in the end of the Plaza wing where the bracing engages four columns. In the upper floors the horizontal struts are pairs of 15-in. channels riveted back to back with ⅝-in. connection plates, have vertical angles from 34 to 51 in. long field riveted to the columns.

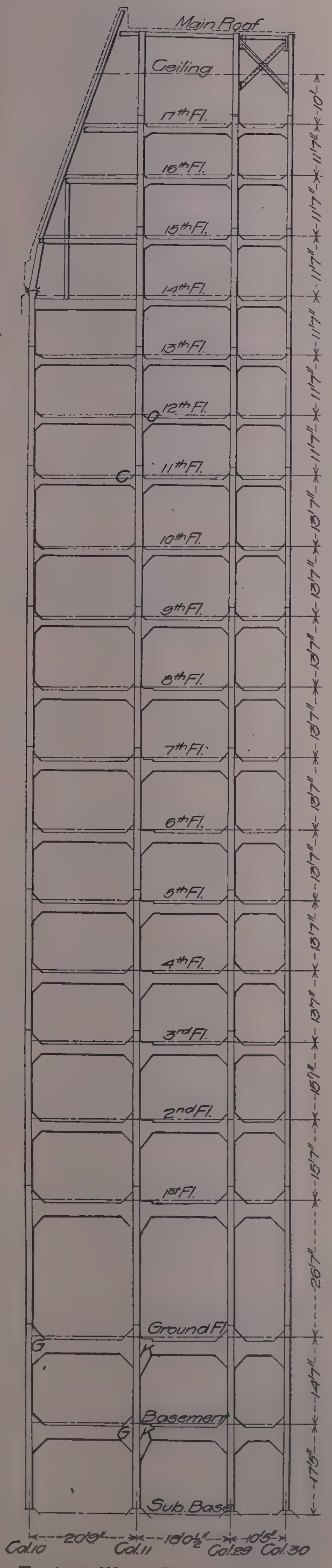
At the fifth floor in the intermediate sets and at the ninth floor in the end wall the pairs of 15-in. channels are replaced by plate girders made with a 20x⅝-in. web and two pairs of 5x3½-in. flange



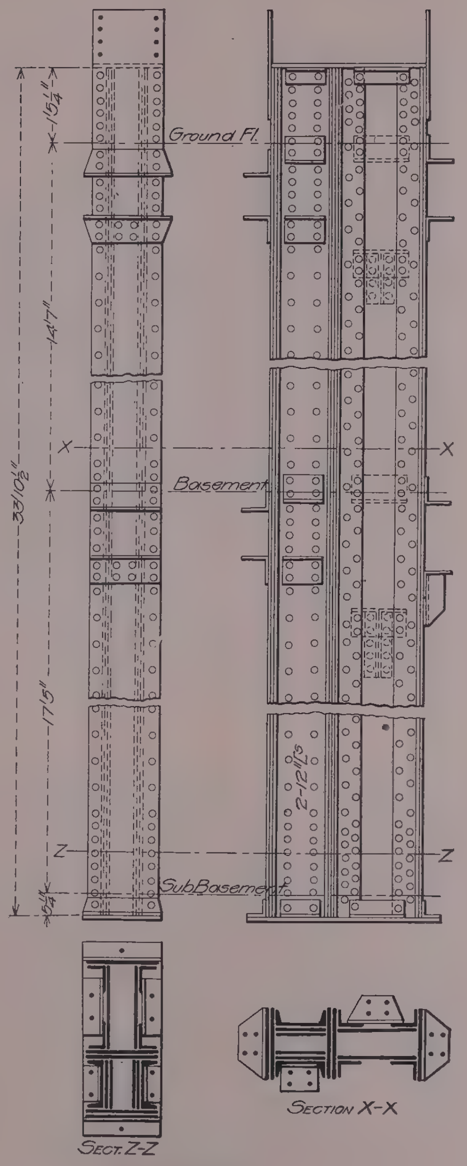
Upper Story Wind Brace.



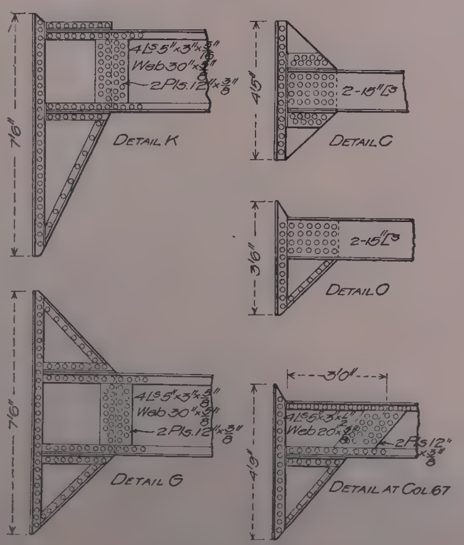
Mansard Roof Rafter.



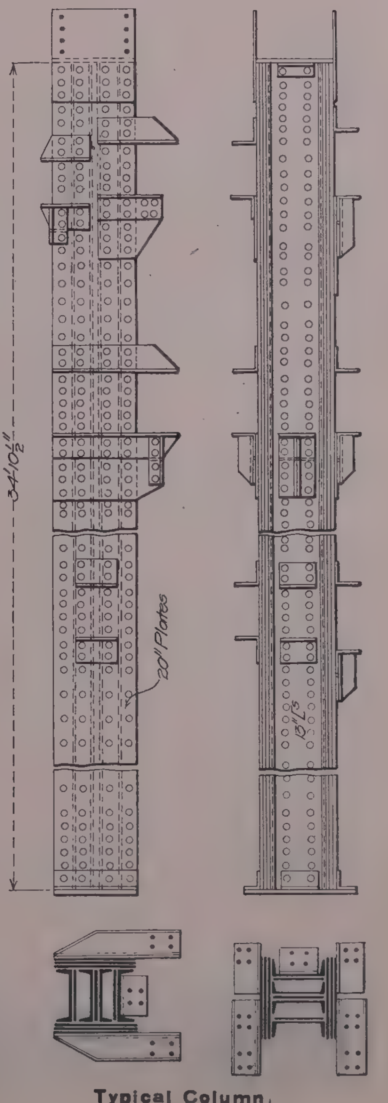
Typical Wind-Bracing Panel.



Double Basement Column.



Wind Brace Connections.



Typical Column.

angles. The girder webs are cut about 2 ft. short at each end and are shop-spliced with double cover plates to side plates projecting beyond the top and bottom flanges and stiffened with pairs of angles on all edges to form kneebraces integral with the girder and provide for the vertical connections 57 to 63 in. long, which are field-riveted to the columns. The dimensions of these girders and kneebraces vary in different systems and are greatest in the end wall, where at the fourth floor the girders are 24 in. deep and the column connections are 69 in. long. At the first floor the girders are 13 in. deep and the connections are 76 in. long with kneebraces on both the upper and lower flanges of the girder. On the intermediate columns kneebraces are on the lower flanges only and the depth of the girders is increased to 24 in. at the lower three floors.

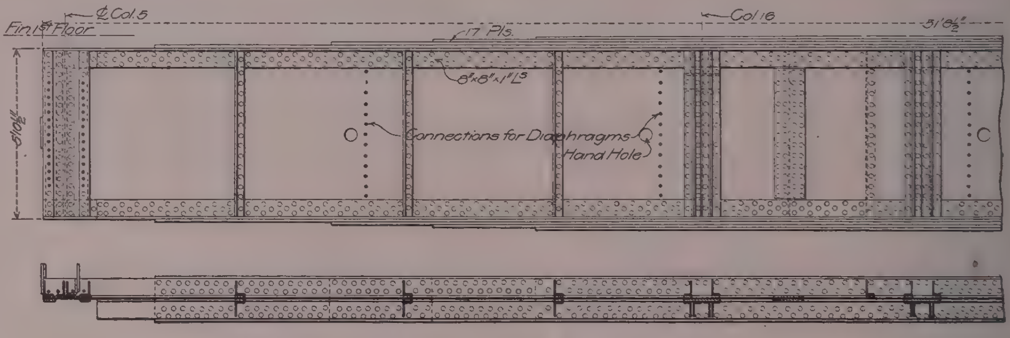
The mansard roof begins at the fourteenth floor and the four stories above this level are braced in some places with horizontal struts and detached kneebraces and in other places are X-braced with diagonal struts. In the former case columns 10½ ft. apart are braced by struts composed of pairs of 12-in. channels back to back connected like floorbeams to the columns. Between them are riveted connection plates which project below the lower flanges and receive the pairs of diagonal 8-in. kneebrace channels having similar web plates with vertical connection angles shop-riveted to the lower ends.

Where the columns are 21 ft. apart the construction is the same except that the depths of the horizontal strut channels are increased to 15 in. and at the upper ends of the columns the channel kneebraces are replaced by single 4x4x⅜-in. angles with their upper ends nearly meeting in the center of the strut. The X-bracing between the columns is made with pairs of 4x3x5/16-in. angles field-riveted to vertical connection plates shop-riveted between the backs of the channels forming horizontal struts. These plates also receive vertical angles 2 or 3 ft. long, which provide field-riveted connections to the columns. In most cases the diagonal angles are only one story in height, but in some instances their panels are two stories high and at their intersection they are cut to clear the horizontal strut of the intermediate floor and are field-riveted to a connection plate between its webs, which projects beyond both top and bottom flanges.

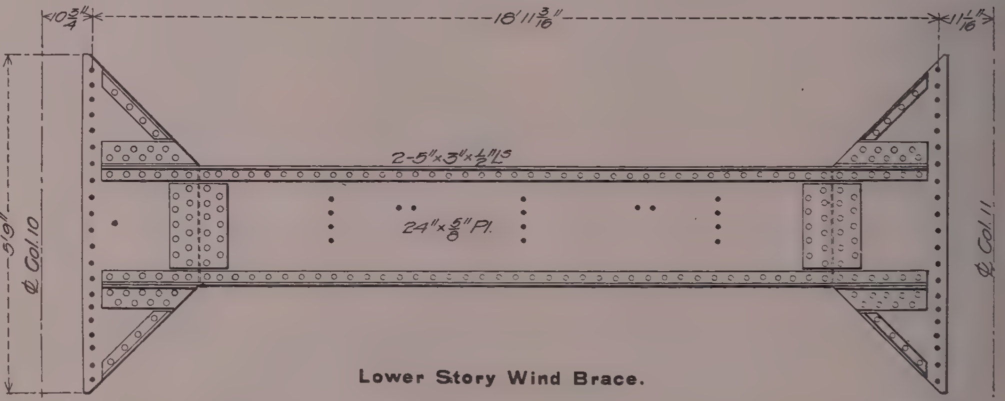
The four-story mansard roof is inclined about 1:2 and the rafters are made with pairs of 12-in. channels riveted back to back with fillers and connection plates between their webs. These inclined rafters carry not only the weight of the mansard roof, but a part of the floors and flat roof, which is forward of the interior corridor columns. This causes a thrust and overturning tendency which is resisted by the bracing which has just been described.

The fillers project at the feet of the rafters to form pedestals stiffened with flange angles and provided with base plates forming seats on the fifteenth story floorbeams and girders to which their riveted flange connections are designed to transmit all of the horizontal thrust. The webs are punched for vertical connection angles from the ends of the horizontal purlins. The rafters are continuous through the four stories of the roof and are kept clear of the outer flanges of the columns. The latter being offset in successive stories to corrrespond with the pitched roof. Column connections are made with thick plates projecting beyond the flanges of the rafters and bent at their inner ends to engage the column faces to which they are field-riveted.

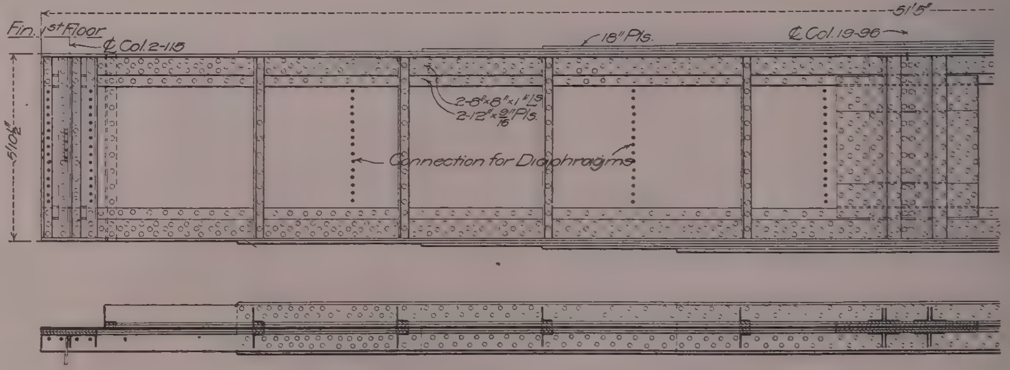
The building contains about 10,000 tons of structural steel, all of which was erected in seven months by a force of about 100 men and seven guyed derricks with 20-ton, 60-ft. booms, which hoisted material from trucks in the street, depositing it on the last tier of beams erected and assembled it in position at a maximum rate of two stories, or 750 tons in six days. There are in the structure about 230,000 ¾-in. field rivets driven by Chicago pneumatic hammers operated with compressed air from Ingersoll-Sergeant machines driven by General Electric motors. The building was designed with lateral stability sufficient to obviate the necessity of temporary bracing during erection, and the simplicity of the details and the excellence of the shop work enabled the members to be assembled with ease and rapidity. Little or no reaming was required and the initial columns having been properly plumbed, the rest of the framework assumed the required position without difficulty.



Girder Carrying Column 16 Above First Floor.



Lower Story Wind Brace.



Half of First Story Double Girder.

Mr. H. J. Hardenbergh is the architect and the George A. Fuller Co. is the general contractor. The steelwork of the building was fabricated by the Carnegie Steel Co. and was erected by the Fuller Co.

Levees Endangered by Floods are sometimes relieved by admitting water behind them, according to Mr. T. G. Dabney. This is done because the head of water may undermine the levee, if it is underlaid by porous material, and "blow-up" behind the embankment. Sometimes low embankments of bags of earth are made to retain the water admitted behind the levee for this purpose, and in other places permanent low embankments enclosing several acres of doubtful ground have been built in order to pond this water at any time required.

A Large Stone-Crushing Plant at Gary, Ill.

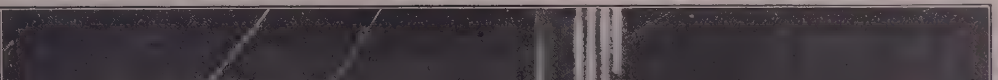
The new stone-crushing plant of the Dolese & Shepard Co., at Gary, Ill., has a rated capacity of 300 cu. yd. an hour and is one of five large crushing plants operated in Chicago and vicinity by that company. The plant at Gary is a few hundred feet west of the Chicago Drainage Canal, on the main line of the Atchison, Topeka & Santa Fe R. R. and 15 miles from the center of Chicago. The Dolese & Shepard Co. has a controlling interest in the Chicago & Western Illinois R. R., a rock-ballasted standard-gauge railroad, 15 miles long, which extends from Willow Spring to Chicago and has connections with important trunk lines between Willow Springs and Chicago and in the city at Western Ave. The other four plants are also served by this railroad as well as by several of the trunk lines and as the company owns about 250 gondola cars built specially for hauling crushed stone, little difficulty is ever experienced in the operation of these plants from a shortage of cars.

The site of the plant at Gary has a very thin covering of soil over a bed of good limestone, which can be worked to a depth of 100 to 150 ft. before water is encountered in sufficient quantities to interfere with operations. The new plant is in a building, 40x317 ft. in plan, along one side of the quarry that has been opened. This building contains a 40x100-ft. engine room at one end, the balance of it being occupied by the stone crushing, elevating and distributing machinery and the crushed stone distributing bins. Steam for operating the equipment of the engine room is supplied from boilers in a detached brick building, which is 22 ft. from the nearest part of the main building.

General View of Quarry and Stone Crushing Plant at Gary, Ill.

The quarry which has been opened covers an area of about 40 acres and is worked to a face of 40 ft. Tracks on an incline lead from the bottom of this quarry to a No. 9 Gates gyratory stone crusher in the main building. Two standard-gauge tracks extend from the foot of the incline to the opposite end of the quarry. Hand-operated turntables are placed at frequent intervals in these two tracks and two to four tracks radiate from each turntable to the working face of the quarry. The rock is loosened at the face in large blasts placed in holes 30 to 40 ft. deep, which are made with 2-in. and 5-in. Ingersoll-Rand drills, Little Jap drills being used afterward for breaking pieces too large to handle. The loosened rock is all loaded by hand into cars on the branch tracks, as the repairs to steam shovels operated in the quarries of this company, due largely to breakage caused by flying stone, have been found to make hand loading the most economical method. The men loading cars in this quarry are all paid by the ton instead of by the cubic yard, as is the usual method. The tracks in the bottom of the quarry are laid on a descending grade from the working face to near the foot of the incline, so that the loaded cars are delivered to the latter with little effort on the part of the horses provided to handle the cars over irregular places. All loaded cars are weighed separately on a track scales at the foot of the incline.

Five tracks are laid on a 40 per cent. grade on the incline and lead from the bottom of the quarry to a No. 9 Gates crusher in the main building. These tracks connect at the top of the incline with two tracks leading into the building. The middle and the two outer tracks are for empty cars descending to the quarry, the loaded cars going up the other two tracks, each of the latter being in line with one of the tracks into the building. The loaded-car track and the outer track on each side, together with the middle track are connected at the upper end of the latter two, just outside the building, by a three-throw stub switch. The stone cars have a capacity of about 6 tons and are hauled up the incline by two 40-in. double-drum Ottumwa hoisting engines in the building, which have a hoisting speed of 500 ft. per minute. An empty car descends as a loaded car is hauled up and as the cables on the two cars are counter-wound on the drums of the hoisting engine handling them, the weight of the stone only has to be pulled up the incline. The switches are operated by a man in the building who also operates the hoisting engines. The two switches connecting the middle track carrying empty cars with the two tracks leading into the building are arranged on one lever so when one switch is closed the other is opened and two cars cannot be shunted on this track at the same time.


View in Engine Room of Crusher Plant During Construction.

The two incline tracks which enter the building end at a dumping platform on either side of the No. 9 Gates crusher where the stone is automatically dumped from the ends of these cars into a chute leading to the crusher. The top of the hopper of the latter is 32 ft. from the ground, the crusher standing on a heavy concrete base rising 19 ft. 2 in. from the floor of the building. The output from the crusher passes through two circular screens, 48 in. in diameter and 18 ft. long, which separate all pieces under the size of 2½-in. cubes. The tailings of these screens fall into a bin from which they are carried by two bucket elevators, on 80-ft. centers, to elevated storage bins over a set of small crushers. The stone passing the screens falls on a 36-in. belt conveyor, on 88-ft. centers, and is delivered to a bucket elevator which discharges into bins feeding a second set of screens at the end of the building from the No. 9 crusher.

The bins which are fed by the two elevators with tailings from the screens at the No. 9 crusher supply stone to two No. 6 and two No. 5 Gates gyratory crushers, set on heavy concrete bases. These crushers all discharge on the 36-in. belt conveyor, which delivers to the bucket elevator leading to the bins over the second set of screens, or they discharge directly into the boot of that elevator. The latter is 85 ft. on centers and has buckets 24 in. wide. These buckets are attached together by two links on pins carried by pairs of angles attached to the back of the bucket. The sprocket wheels operating the elevator have teeth which can be removed and replaced separately, without dismantling the wheels. The belt conveyor and all three elevators were furnished by the Webster Mfg. Co., of Chicago.

The bin to which the last elevator discharges is arranged to supply four circular screens, 40 in. in diameter and 24 ft. long. These screens have three sizes of openings varying from those which pass pieces of ¼-in. dimensions and under to those that will pass 2-in. cubes. The various sizes are delivered from the screens to storage bins, with their floors elevated 17 ft. above the floor of the building on heavy concrete footings. The tailings of the screens also pass into an elevated storage bin at the end of those receiving the product of the screens. These four bins have a combined capacity 2,000 cu. yd. The stone is fed by gravity directly from them into cars, a standard-gauge track being laid along both sides of the building.

Under present conditions the output of the plant is all required for shipment, so no storage is possible. Provisions have been made, however, so any surplus output during dull seasons may be stored and the storage drawn on when necessary. The tailings and the product of the screens can be delivered directly on four 18-in. belt conveyors which extend out from the main building over storage space on the side opposite from quarry. These conveyors are 31 ft. above the ground on a trestle with spans of 70 ft. One conveyor is arranged to carry the tailings of the screens, which are delivered to the space under the first 70-ft. span of the trestle. The other three conveyors extend to the second, third and fourth 70-ft. spans, respectively, and each carry one of the three sizes of stone passing the screens. A track is laid under each span close to the bents carrying the trestle so the stone can be reloaded from the piles into cars by a steam shovel.

The large size stone rejected by the first set of screens are used for flux in the blast furnaces of the Illinois Steel Co., a train of cars of stone of this size being hauled away from the plant every night. The remainder of the output of the plant is used for making macadam roads, for concrete and various other purposes, the screenings which were formerly largely wasted now being much in demand as a substitute for sand in concrete work.

The boiler house of the plant is a brick building 53x59 ft. in plan, which contains four 150-h.-p. Kewanee return tubular boilers. The engine room in the main building is entirely separated from the crusher machinery rooms. It has a concrete floor and is sheeted on the inside so the dust from the crusher rooms is excluded. A 600-h.-p. Allis-Corliss engine in the engine room furnishes power to drive the machinery of the plant. The No. 9 crusher is belt-driven from a line shaft in the engine room, this shaft being belted in turn to the fly-wheel of this engine. A Dodge system of rope-drive transmits power from this line shaft to drive the other crushers, the screens, elevators and belt conveyors. The sheave wheels for this rope drive in the engine room are enclosed to prevent the dust from the crushers reaching that room. An Ingersoll-Sergeant air-compressor, with a capacity of 1,000 ft. of free air per minute when operating against 100 lb. pressure, is installed in the engine room and furnishes power to operate the drills used in the quarry. A small generating set also supplies electrical power for lighting.

The plant was designed and built under the direction of the engineering department of the Dolese & Shepard Co., of which Mr. O. P. Chamberlain is chief engineer.

HYDRAULIC SLUICING is being employed at Seattle, Wash., for the removal of a large hill in the residential section of the city. The material consists principally of blue clay, which is exceedingly tenacious and hard to move, but is easily handled by a 6-in. giant nozzle at 120-lb. pressure hydraulic. The supply of water is taken from Puget Sound, some 2,500 ft. distant, and delivered by a 30-in. four-stage Worthington turbine pump, belt-driven by a 40-h.-p., two-phase induction motor, which is supplied with current from the 2,400-volt mains of the Seattle Electric Co. The pump has developed a capacity of 4,000 gal. per minute against a head of 430 ft.

Part of Rope Transmission System at Gary Crusher Plant.

Railroad Drawbridge Recommendations in New York State.

The New York State Board of Railroad Commissioners had its inspector, Mr. J. D. Schultz, make an examination a few months ago of all the drawbridges on the main tracks of steam roads in the State. There are 41 of these bridges, of one type or another, which differ greatly in their method of operation, the protection of the draw, the connection of the shore and bridge rails, and other details. None of the conditions are considered dangerous by Mr. Schultz, but, acting on this advice, the Board has issued the following recommendations regarding such structures:

The method of securing the movable rails, necessarily unspiked for much of their length, at the ends of most drawbridges, the manner of signaling the approach of the draws, and the interlocking of the signals with the mechanism operating the draws, can in nearly all cases be improved. There should be derailing switches in all tracks approaching the draws, located a sufficient distance from the end of the bridge that a train derailed thereby would not be likely to run far enough, on the ties, to get into the draw opening; guide rails can be secured to the ties that will prevent a train so derailed getting away from the track.

The movable rails on ends of all drawbridges should extend 2 ft. or more beyond the end of the bridge, and, together with the shore rails, have a miter joint; rails cut at an angle of approximately 30 deg.; points to be trailing for double track bridges and to be trailing for wheels approaching the draw on single track bridges; the mitered rails to meet in a "trough" or channel not less than 3 ft. in length, that will insure the rails being held in correct alignment; the movable rails to be bolt-locked in position and the bolt-lock to be interlocked with the signals governing the approach to the draw; the movable rails to be not less than 17 ft. in length and for at least 12 ft. of their length, on the bridge, to rest when in place on plates that shall have an angle or raised plate on the outer side that will prevent the rails being moved outward. This plate may be in sections, with space of one tie distance between the sections. These plates are to be firmly secured to the bridge ties, and the rails to be connected to each other by at least four tie-bars.

The draw must be protected by home and distant signals and also by derails, the derails to be located, wherever practicable, not less than 500 ft. from the end of the draw, the home signals about 50 ft. farther away, and the distant signals not less than 1,500 ft. beyond the home signals, and all interlocked with the mechanism of the draw in such manner that the first movement toward opening the draw sets the distant signal to the danger position; next, the home signal to the danger position, then opens the derail; then the bolt-lock securing the movable rails may be withdrawn, the rails raised, draw unlocked, wedges withdrawn and draw opened. The locking to be in such manner that when the draw is again closed, the wedges inserted and draw locked, movable rails lowered to place and bolt-locked down, then derails can be closed, home signal cleared and the distant signal cleared, and that the above described movements can only be done consecutively and in the order named. In cases where the draw lifts, the rails on the end of the bridge can be securely spiked to the ties and will rise and fall with the bridge, but the method of connecting them at the ends of the draw will be the same, as will be the method of operating the bridge, bridge lock, rail lock, derails and signals.

If it is desired to use square end instead of mitered rails, with all the balance of protection, etc., as above described, the only difference will be that the open joint will not ride quite so pleasantly, but will be practically as safe, and there is, therefore, no serious objection to its use. In some cases where the block signal system is in use and block towers are near the drawbridges, the draws are interlocked with the towers in such manner that the bridge tenders cannot make any movement towards opening the draws until unlocked by the signal tender. This is a good plan and should be followed wherever it can be done consistently.

Spike Shear on Railway Curves.

In its investigations to ascertain the action of electric locomotives on curved track, the New York Central & Hudson River R. R. Co. has secured a considerable amount of interesting information from various sources, a part of which is given here through the courtesy of Vice-President W. J. Wilgus. Among the engineers consulted by the company is Prof. George F. Swain, whose long connection with the Massachusetts Railroad Commission lends special interest to his statements regarding the action of the company's electric locomotives in passing around curves.

In his computations he assumed the coefficient of friction between wheel and top of rail as 0.25, and the coefficient of friction between base of rail and tie plate as the same. The action of the pony truck, which is transmitted to the rigid frame by means of the spring and pivot, was taken into account in each case, but the friction on the sliding plate by which the vertical load is carried to the pony truck was considered separately in order that it might be omitted, if it were thought that it ought not to be allowed for.

The second driving axle has a certain amount of play laterally so that it will tend to work to the outside of the curve and make the pressure on the forward driver less than if the forward driver were the only one upon which the pressure were exerted. Whether the second driver will come into action in this manner depends, Prof. Swain reported, upon its play laterally and upon the precise position which the locomotive assumes upon the track, as well as upon the perfection of the alignment of the track. This was studied with various positions of the truck upon the track as follows:

(1) In which the rear driving axle is radial, with inside wheel close against inside rail.

(2) In which rear driving axle is pushed outward a little until outward wheel of rear pony is against rail, but without compressing the spring.

(3) In which the rear driving axle is pushed outward still further until outer rear driver is in contact with the outer rail.

With the play of the second axle as given to him, he reported that it would be possible in each of these three cases for the second outer driver to be in contact with the outer rail, but the margin for possible inequalities in the track would be different in the three cases; for (1) it would be about 0.03 in.; for (2) it would be about ⅛ in., and for (3) it would be about ¼ in. In other words, it is more probable that the second driver would relieve the leading driver if the position were as assumed in case (2) than it would if the position were as assumed in case (1), and more probable still if the position were as assumed in case (3).

The accompanying table gives a summary of the conclusions reached by Prof. Swain.

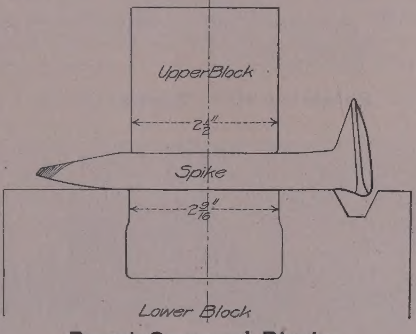
Another point of some uncertainty in the problem is as to the distribution of the pressure of the forward driver upon the spikes. If this pressure is exerted directly over a tie, the outer spike on that tie would carry a greater portion of the pressure than any other spike, and if no yielding could occur either in tie or in spike, this spike would carry the whole of the load. Any yielding, however, no matter how slight, would distribute the load upon the two spikes on either side, these two carrying less than the first spike. In a similar manner, if the pressure were exerted midway between two ties, the two spikes on these ties would carry one-half the load, if no yielding could occur; but any yielding however slight would distribute the load upon other spikes on either side. It is impossible for anybody to tell just how much pressure would be carried upon the spike which is most stressed, but it is Prof. Swain's judgment that the pressure should be considered as distributed upon two spikes. It is possible to imagine cases in which nearly the whole load might be carried by one spike, but those would be cases where the track could not be said to be very perfect.

TABLE OF EFFECT OF ELECTRIC LOCOMOTIVES ON TRACK.

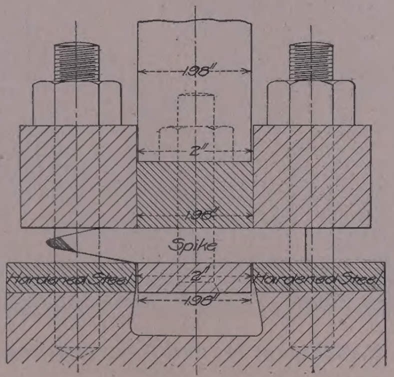
Speed, miles per hour	57.6	60	70	80	90
Allowing for friction between base of rail and tie plate, but not for friction of sliding plate of pony truck or for pressure of second driver against outer rail, the pressure of leading driver against outer rail will not exceed	4,300	5,200	8,400	12,300	16,800
If friction of sliding plate of pony truck is also allowed for, pressure of leading driver against outer rail will not exceed	3,200	4,100	7,300	11,200	15,700
If second driving axle slides laterally so as to bear against outer rail, pressure of leading driver will not exceed	2,100	3,000	6,200*	10,100†	14,600‡
Friction on base of rail under outer leading driver	4,375	4,435	4,735	5,085	5,500
On an approximately perfect track the pressure of the leading outer driver would not exceed	3,000	3,000	3,500	8,000	11,000

* Will probaby not be over 3,000. † Will probably not be over 6,800. ‡ Will probably not be over 11,000.

Another uncertain element in the problem is the question of impact. The pressure upon the spikes is not suddenly applied, but is applied very quickly, and with a good track it would not be applied with a shock; there would be a steady pressure of the outer wheel against the rail in passing around a curve. If the load were applied instantaneously to a spike the impact would be 100 per cent.; if the load is applied gradually, as it is in fact, the impact will depend upon whether it is applied more quickly than the strain can follow it.



Round-Cornered Blocks.



Knife-Edged Blocks.

Another element, also, must be taken into account, namely, the fact that although the load is applied quickly it is removed just as quickly. If the quick application of a load is a disadvantage the quick removal of it is an advantage, like skating over thin ice. Everybody knows that if his speed is considerable, a skater can pass over ice so thin that it would not bear his weight for an instant without breaking. The quick removal of a load, therefore, tends to offset any impact caused by its quick application.

As a result of his study of this problem, Prof. Swain is convinced that with a good track it would not be possible for these electric engines running around a 3° curve at a speed of from 60 to 70 miles an hour, or even higher, to shear the spikes on the outer rail, assuming the ultimate strength of a spike to be 17,000 lb. If the cross-section of the spike were reduced by wear by one-ninth, the breaking strength would be reduced to 15,100 lb. Prof. Swain does not believe the pressure of the leading driver against the outer rail at a speed of 60 miles an hour would be above 3,000 lb. (and it assuredly would not be above 5,200 lb.) or at a speed of 70 miles an hour above 3,500 lb. (and it would assuredly not exceed 8,400) so that there would be a considerable margin in either case. It must further be borne in mind, he reported, that it will require a stress considerably above the elastic limit in order to break a piece of metal, even with many thousands or millions of applications, the number of applications required being less as the ultimate strength under a single application is approached. For instance, reliable tests indicate that for steel in tension a stress of seven-tenths of the ultimate strength would have to be applied some 4,000,000 times in order to break a piece, and that a stress of about five-eighths of the ultimate strength would require 6,000,000 or 7,000,000 applications. Experiments, of course, vary with regard to the number of applications necessary. If there is any defect in the material at any point the effect of repeated applications is to cause a failure at this point and with a less number of repetitions than if the material is perfect, but even with a defect, a stress of seven-tenths the ultimate is likely to require half a million or more applications.

In order to ascertain the strength of the Goldie track spikes used on its lines, the New York Central & Hudson River R. R. Co. requested Messrs. Robert W. Hunt & Co. to carry out a series of tests which should settle the matter. Tests were accordingly made of six spikes in double shear, using the shearing blocks as shown on the accompanying sketch No. 1. These shearing blocks do not give a complete knife-edge shear, but in the opinion of Messrs. Hunt & Co. approach very closely the actual shearing, bending and tension stresses obtaining in actual service where a spike is sheared off by flange of rail.

The results of tests are given in Table I.

The elastic limit, or rather the yield point, was obtained as closely as possible from the action of the beam of the testing machine and also from a close observation of the spike itself. Messrs. Hunt & Co. believe that the approximate elastic limit obtained under the given conditions does not vary more than 2½ per cent. from the actual. There was practically no bending of the spike until the elastic limit was reached.

TABLE 1.—RESULTS OF TESTS OF SPIKES.

Test No.	Width of spike.	Height of spike.	Approximate elastic limit.	Maximum load.
1	0.624 in.	0.622 in.	9,500 lb.	37,880 lb.
2	0.591 "	0.608 "	10,500 "	40,460 "
3	0.631 "	0.592 "	10,500 "	38,640 "
4	0.630 "	0.597 "	12,000 "	38,820 "
5	0.626 "	0.601 "	10,900 "	40,930 "
6	0.634 "	0.609 "	10,000 "	40,160 "
Average.	0.6226 in.	0.6048 in.	10,566 lb.	39,481 lb.

The average approximate elastic limit or yield point in either double or single shear was 10,566 lb. The average single shearing load of spike was 19,740.5 lb. and the average single shearing load of spike was 52,420 lb. per sq. in.

These results were obtained in the straight portion of the spike. While the spike in service would fall nearer the head where the area would be greater, the area of the spike where tested was 0.3765 sq. in., and the area of the spike at the base of rail where the shear would probably take place is about 0.4225 sq. in.; therefore the approximate elastic limit and the shearing load at the latter point would be in the proportion of 0.4225 to 0.3765, when compared with those actually obtained in the straight portion of the spike. The approximate elastic limit and the shearing load of the spike at the base of rail would therefore be 11,855 and 22,145 lb., respectively.

Tests were also made in block which would give a knife-edge shear. With these testing blocks the entire spike is rigidly clamped and there cannot be any bending of the portion of the spike corresponding to the head and a short length of the shank as would probably be the case in service.

Table 2.—Results of Spikes.

Test No.	Width of spike.	Height of spike.	Approximate elastic limit.	Maximum load.
8	0.624 in.	0.608 in.	13,000 lb.	36,550 lb.
9	0.627 "	0.598 "	14,000 "	38,790 "
10	0.625 "	0.592 "	12,000 "	37,810 "
11	0.627 "	0.608 "	11,500 "	36,880 "
Average.	0.6257 in.	0.601 in.	12,625 lb.	37,507 lb.

The heads were cut off of four spikes and tested in this device, with the results given in Table 2. The approximate elastic limit or yield point is raised when tested under these conditions, and at the same time the maximum shearing load is lowered.

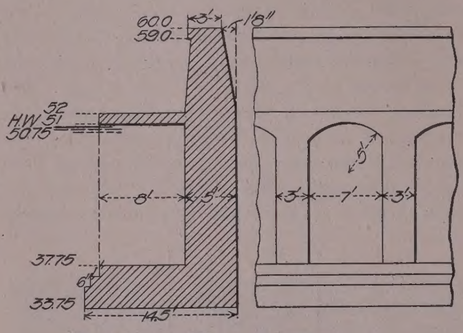
The average approximate elastic limit or yield point in either double or single shear was 12,625 lb. The average single shearing load of the spike was 18,753 lb. and the average single shearing load of the spike was 49,807 lb. The approximate elastic limit or yield point and the shearing load of the spike at the base of the rail would, therefore, be 14,165 and 21,062 lb., respectively.

The U. S. Cement Industry during 1906 is reviewed by the U. S. Geological Survey in the following statement, stated to be exact within a small fraction of one per cent. "The total production of all kinds of hydraulic cement in 1906, including Portland, natural rock and Puzzolan cements, was 50,027,321 barrels, valued at $54,015,713. Of the above total amount of cement manufactured in the United States in 1906, 45,610,822 barrels were Portland cement, with a value of $51,240,652; 3,935,275 barrels were natural rock cement, with a value of $2,362,140, and 481,224 barrels were Puzzolan cement, valued at $412,921. Prices were good in 1906, and showed an advance over those of 1905. The total production of cement in 1905 was 40,894,308 barrels, valued at $36,012,189. Comparison of totals for 1905 and 1906 shows an increase in 1906 of 9,133,013 in production and $18,003,524 in value."

The Section of the Barge Canal Connecting the Hudson and Mohawk Rivers.

By H. P. Willis, Resident Engineer.

This section of the new canal is one of the most interesting pieces of location and construction along the entire route. As originally designed, it left the Hudson just below the Union Bridge at Waterford, and entered the Mohawk a short distance above the Cohoes Falls. The difference in elevation between these points is 155 ft., and was to be overcome by two single and three double combined locks. The height of the dam in the Mohawk at the head of the last level was to be 42 ft.



Retaining Wall, Contract 2.

When surveys for final location were made, a route was found which was shorter than the proposed route and which reduced the cost of construction by over a million dollars. The new route started from the same point, but entered the Mohawk about one mile above, where the elevation of the rock was found to be 17 ft. higher across the river channel, and 40 ft. higher from the channel to the hill at the side of the valley. By placing the dam at this latter site, it was possible to get a length of crest much longer than the old and at a reduced cost. It was also found to be more economical to raise the crest of this dam 13.77 ft. and thus save the proportionate excavation in the summit level, all of which is rock. The height of the river section of the new dam will be about 37 ft., and the length about 750 ft., while the height of the wing section will be about 12 ft., and its length about 750 ft.

The new route follows a valley which rises gradually for nearly the entire distance between the rivers; at the end, however, are two hills, 60 ft. in height, through which it will be necessary to excavate. By this route, only five single locks are necessary to overcome the difference in elevation of 169 ft. This replaces the three double combined locks as originally designed by three single locks.

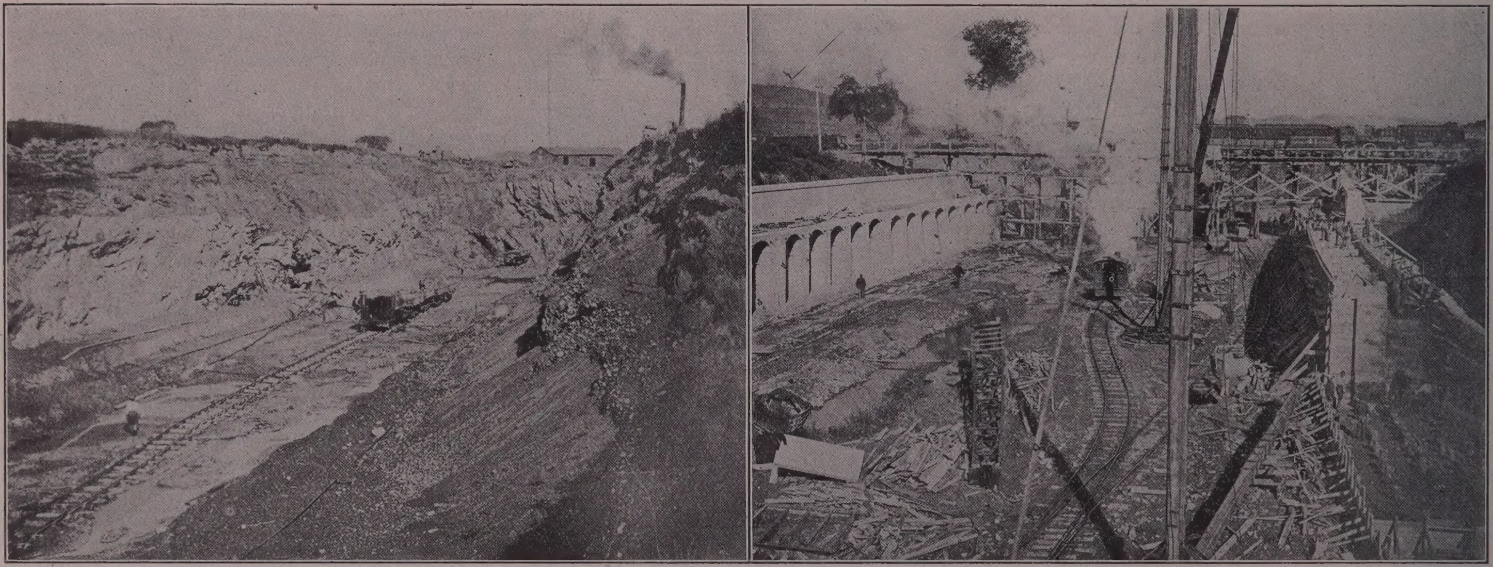
As the new route goes through the lower section of the village of Waterford, it was necessary to appropriate sixty parcels of land upon which were forty-five buildings, all of which, with one exception, were cheaply constructed.

The route was carefully covered by borings which have proved to be of the greatest value in locating structures, and to the contractor; both in figuring his bid and in the composition of his plant. The location of each of the five locks was determined by the result shown in the boring records, and it has been possible to locate each of them on a rock foundation almost at grade, so as to reduce the excavation of rock to a minimum. The excavation done to date verifies exactly the results shown in these records.

The following table shows the amount of preliminary work done on this section and its cost:

Topog. Sq. mi.	Transit lines. Miles.	Levels. Miles.	Cost of field surveys.	Borings. Ft. in. Depth.	Cost of borings.
4.50	28.00	62.00	$12,322.44	9687	$10,758.20

The estimated cost of construction on this section, exclusive of the dam, is $2,856,437; the principal items being 1,385,000 cu. yd. of excavation and 262,500 cu. yd. of concrete.



Completed Excavation for Lock 3, Contract 11, and Retaining Wall Construction on Contract 2.

The section between the two rivers is 2.51 miles in length and is all included in two contracts; the Ferguson Contracting Co. having Contract 2, and the Fort Orange Construction Co., Contract 11. Construction began in June, 1905, and to date, the excavation for Locks 2, 3 and 5 is practically completed, and the heavy excavation through the village of Waterford is finished. The only concrete work which has been done is the construction of the retaining walls through Waterford. These walls are recessed and of peculiar design; and answer a three-fold purpose. They give a very wide base and also answer the purpose of a concrete dock, without being extremely heavy; the weight being 280,714 lb. per 10-ft. section. In addition to aiding the purposes just given, the recesses add materially to the number of square feet of water surface, and as this level is short, this is a factor of considerable importance.

Electrification of Railway Lines is being investigated by the Delaware & Hudson Co., to determine the practicability of electrically operating its lines between Wilkesbarre and Carbondale, Pa., and its coal mines and breakers in that vicinity.

Experimental Roads of the Illinois Highway Commission.

During the past year the Illinois State Highway Commission has built several experimental macadam roads in various sections of the state, using for the greater part of this work crushed limestone supplied free from the rock-crushing plants at the state penetentiaries. In most instances the money required for the work was provided by private subscription, the township officials also making small appropriations and agreeing to do part of the work. Some communities were ready with more money than others and to a considerable extent this affected the selection of sites for the experimental roads though at the same time they were distributed over the state and built under varying conditions as much as possible.

The method of construction was practically the same in every instance. The limestone used is too soft for macadam roads, although good when compared with other limestones found in Illinois. The usual method of placing the small size stone in the top layer with the larger stone underneath was reversed, on account of the softness of the stone; that is, the 1½-in. material was placed in the bottom course, while the 3-in. material was placed on the top of the road. In this way it was possible to use the entire product of the crusher and at the same time avoid the small pieces of rock in the surface of the road which would be easily ground up owing to the soft nature of the material, whereas the larger pieces of rock are stronger and offer more resistance to the crushing effect of the traffic. It is found that material handled in this way will make a road two or three times more durable than if the material were used in the manner employed when hard trap rocks or granite are used.

As fast as the road bed was graded and shaped, narrow trenches were cut through the earth shoulders about every 50 ft. on either side. These side trenches or laterals were filled with broken stone to the depth of the first course of stone in the road. The object of the laterals is to drain the road bed, particularly during the construction before the broken stone has been rolled and made waterproof with the binder course. If this precaution is not taken, rain will readily go through the porous stone covering and will settle in the road bed, when no further work can be done until it is dried out, which will often take a number of days where a sticky clay soil is encountered.

In each instance the road bed was carefully shaped to the proper cross section and thoroughly rolled. On it was then spread the first layer of stone, usually 6 in. thick, measured loose. The material was evenly distributed by the aid of blocks, which were set one at each side and one in the middle of the subgrade. This first layer was thoroughly rolled, and the second layer was then spread the same thickness and also thoroughly rolled. Screenings were then applied and were watered and rolled until the mud thus formed would flush to the surface, which showed that the surface of the road was practically watertight. The shoulders were shaped to conform with the crown of the road, which was 1 in. to the foot.

The greatest difficulty encountered in isolated stretches of macadam road in sticky, muddy country, according to the annual report of the Illinois Commission from which these notes have been taken, is to prevent the road from picking up, as will surely happen, especially in the first winter, unless some special means of protection is taken. On the experimental road at Springfield one end of the road was covered for a short distance with tar, which has proved effective so far in keeping the road surface intact. At the other end of the road the mud has loosened some of the material for a short distance, making it necessary to keep careful watch of the road and to supply some loose material for the mud to take hold of. After a road has had a season's traffic and become thoroughly set, there does not seem to be the same difficulty as is experienced with new stretches of road.

A daily record was kept of all work done in the construction of these roads, and the amount of material used was also recorded. As the material was furnished free from the penitentiaries, detailed cost items are shown for the labor only, but with a given amount of material and a given price, estimates can be made of the total cost of the work when the amount of labor necessary is known. The cost of culverts and bridges has been omitted. The difference in the labor cost of the experimental roads which were built in the past season is due chiefly to the character of the labor available, according to Mr. A. N. Johnson, State Highway Engineer. Cost data kept on three of the Illinois experimental roads is here given.

Springfield-Pawnee Road, Sangamon County.—The first half mile of this road is over black gumbo soil, and is very level, the maximum grade that could be secured being 0.08 ft. per 100 ft. The south end of the road has a uniform grade of 0.35 ft. per 100 ft., and the soil on the last half or one-third of a mile is considerably less sticky than that encountered in the first half. In the center of the road, and 3½ ft. below the top of the finished surface, a 6-in. tile drain was laid for a distance of 4,000 ft. After the tile were laid the trench was carefully back filled with burned shale. The contract price for this under drain was $1.75 per rod.

Four different materials were used in the construction of this road: Limestone from the state penitentiary at Joliet, limestone from the state penitentiary at Menard, burned shale from a coal mine dump about 1,000 ft. from the road, and chert gravel from Kinderhook, situated about 60 miles west on the Wabash R. R. All the stone and gravel were shipped by rail and delivered at a siding about 800 ft. from the north end of the road, the average haul being little over half a mile. The north end of the road for a distance of about 1,700 ft. was constructed with a shale foundation 6 in. thick, over which was placed a limestone top, also 6 in. thick. For the first 1,000 ft. on the north end shale shoulders were constructed on either side 7 ft. wide; on the remainder of the road earth shoulders were made. The macadam for the half mile at the north end was made 16 ft. wide and on the south half mile 12 ft. wide. This road was made unusually wide on its north end because it is a continuation of an important street in Springfield, Ill., the state capital, and the abutting property will be used soon for residences.

The following is a summary of the general conditions and amount of work on the Springfield-Pawnee road: Length, 5,200 ft.; width of macadam, 12 and 16 ft.; square yards of macadam, all stone, 5,133; square yards of macadam, shale base, 3,022; square yards of shale shoulders, 1,555; average haul for stone, ¾ mile; average haul for shale, ¼ mile; cubic yards of stone in road, 3,500; cubic yards of shale in road, 895; cubic yards of shale in shoulders, 465; labor, $1.75 per day for men, and $3.50 per day for two-horse team, nine-hour day. The costs were as follows: Excavation, $1,061.33; laying tile drain, $202.25; shaping road bed, $136.42; unloading stone from cars, $314.96; hauling stone, $600.48; loading and hauling shale, $461.02; spreading stone, $359.74; spreading shale, $78; trimming shoulders, $223.36; rolling, sprinkling coal, oil, etc., $610.62; superintendence, watchman, water boy, ice and drinking water, $530.30; total labor cost, $4,578.48.

Unit costs for labor were: Unloading stone, $0.09 per cu. yd.; hauling stone, $0.172 per cu yd.; spreading stone, $0.103 per cu. yd.; loading and hauling shale, $0.237 per cu. yd.; spreading shale, $0.060 per cu. yd.; rolling and sprinkling, $0.111 per cu. yd.

McLean Road, McLean County.—This road was built entirely of crushed limestone, 12 ft. wide and with 5-ft. shoulders. The general conditions and amount of work are as follows: Length, 5,400 ft.; width of macadam, 12 ft.; square yards of macadam, 7,225; average haul for stone, ¾ mile; cubic yards of stone in road, 2,962; labor $1.75 per day for men, and $3 per day for two-horse team, nine-hour day.

The costs were as follows: Excavation, $111.20; shaping road bed, $205.55; unloading stone from cars, $225.14; hauling stone, $693.76; spreading stone, $116.90; trimming shoulders, $95.16; rolling, coal, oil, etc., $192.43; superintendence, $154; total, $1,794.14.

The unit costs for labor were: Unloading stone, $0.076 per cu. yd.; hauling stone, $0.234 per cu. yd.; spreading stone, $0.039 per cu. yd.; rolling and sprinkling, $0.065 per cu. yd. The total labor cost was $0.246 per square yard of finished macadam.

Greenville Road, Bond County.—This road is comparatively level and required only a small amount of grading for the road bed, which was made 12 ft. wide, flanked on either side with shoulders 6 ft. wide. The soil is a brownish yellow clay. The general conditions and amount of work are as follows: Length, 5,300 ft.; width of macadam, 12 ft.; square yards of macadam, 7,066; average haul for stone, ½ mile; cubic yards of stone in road, 3,198; labor, $1.75 for men, and $3.50 per day for two-horse teams, nine hours.

The costs were as follows: Excavation, $297.11; shaping road bed, $111.36; unloading stone from cars, $148.38; hauling stone, $806.48; spreading stone, $229.62; trimming shoulders, $70.79; rolling, coal, oil, etc., $112.76; superintendence, watchman, water boy, $252; total labor cost, $2,028.50.

The unit costs for labor were: Unloading stone, $0.044 per cu. yd.; hauling stone, $0.24 per cu. yd.; spreading stone, $0.074 per cu. yd.; rolling, $0.035 per cu. yd. The total labor cost per square yard was $0.276.

Book Notes.

Manufacturers and shipping agents engaged in foreign trade frequently have occasion in making out documents required by foreign customs authorities to give the weights of the shipments in kilograms. A little book which will help in preparing these statements is Mr. F. W. A. Logan's "English Weights with their Equivalents in Kilograms." These equivalents have been calculated from 1 lb. to 1 ton by pounds and from 1 ton to 100 tons by tons. (New York, Spon & Chamberlain, 50 cents.)

Now that electrical apparatus is used in so many places that an acquaintance with the work to be obtained from it is a necessary part of the knowledge of most engineers and architects, without regard to their specialties, such a book as Mr. Frank W. Roller's "Electrical and Magnetic Measurements and Measuring Instruments" is likely to prove useful to a wide circle of readers. It is written for all who wish to know about such measurements, from the simple testing out of lines to the elaborate determination of complicated designs. The book is in no sense a treatise on the design of and construction of instruments, although they are sufficiently described to enable the reader to substitute one or more pieces of apparatus which he may have for another that he does not possess. Enough information is also given to enable the reader to pick out the types of apparatus best suited for any special measurements that may be in hand. The contents of the book are grouped into three parts. The first opens with definitions of units and a description of laboratory and commercial standards of resistance, current, electromotive force, capacity and inductance. Then follow chapters on galvanometers and potentiometers, after which the author takes up in succession the methods and apparatus for measuring resistance, current, potentials, power, capacity, inductance and wave forms, frequency and other miscellaneous properties. A special chapter is devoted to methods of locating faults. The second part of the book contains three chapters on recording instruments, integrating meters and maximum demand meters, and will be found particularly useful to readers who purchase considerable quantities of electrical current and are consequently interested in knowing about the instruments whose readings fix the amounts of their bills for such service. The third part is on magnetic measurements. Special care has been paid to the preparation of the diagrams, which are lettered in an unusual manner making them very clear. (New York, McGraw Publishing Co., $3.50.)

The attention now being paid to the use of concrete as a material for shops makes the appearance of "Concrete Factories" particularly timely. It has been compiled by Mr. Robert W. Lesley, whose intimate relations with the concrete industry give him special opportunities for securing information on the subject. The book is as valuable for engineers and architects as for shop managers. It opens with an account of the work being done by what is known as the Joint Committee on Concrete and Reinforced Concrete, which is made up of representatives of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering and Maintenance of Way Association and the Association of American Portland Cement Manufacturers, with additional cooperation from the National Board of Fire Underwriters, the National Fire Protection Association, the Concrete Block Machine Manufacturers' Association and the National Association of Cement Users. The tests of mortar and concrete building blocks which are planned by the Structural Materials Testing Laboratories of the United States Geological Survey, with the approval of the United States Advisory Board on Fuel and Structural Materials, are also explained in detail. These two papers show conclusively the importance attached to the subject of concrete construction by the leading engineering associations. The portion of the book which will appeal most directly to engineers and architects is the translation of the rules for the use of reinforced concrete issued by the Minister of Public Works of France and prepared by a committee consisting of representatives of the national bureau of bridges and highways, the artillery and engineering corps of the French army, the architectural and engineering professions and the contracting specialists in reinforced concrete. In many respects these regulations represent the best practice in such work and anybody who follows them carefully need have no hesitation about the security of the structures so far as their planning is concerned. Following this chapter is one describing in a general way the field of reinforced concrete construction as applied to building purposes, in which illustrations are given of a large number of notable structures erected recently or now under construction. The subject of concrete in factory construction is then taken up in detail and a large number of shops and industrial buildings are illustrated and described. There is a special chapter on the surface finish of concrete, written by Mr. H. H. Quimby, whose success in securing attractive surfaces on recent concrete work in Philadelphia is well known. (Philadelphia, Pennsylvania Bldg., American Cement Co., $1.00.)

Letters to the Editor.

The Miners' Inch.

Sir: Referring to a paragraph in the "Record" on page 292, Vol. 55, No. 9, giving the value of one second-foot in miners' inches, I find in my notes a table, taken from the "California Journal of Technology," giving similar data for a number of States.

	By Custom, Miners' Ins.	By Statute, Miners' Ins.
California	50	40
Colorado	38.4	38.4
Montana	40	40
Idaho	50	
Arizona	40	
Nevada	50	
Utah	50	

The California Statute, approved March 23, 1901, reads: "Section 1.—The standard miners' inch of water shall be equivalent, or equal to one and one-half cubic feet of water per minute (.025 cubic feet per second), measured through any aperture or orifice."

In Nevada, local custom in different parts of the State measures the miners' inch under varying heads of from 4 to 12 in.

Yours truly,

Tacoma, March. 16. F. H. Cushman.

The State Control of Water Supplies.

Sir: The writer is very much interested in the editorial in your issue of March 10, on page 343, under the caption of "The State Control of Water Supplies." Some things which are there exploited are very interesting to the writer, and your attention is directed to something that is going on in the State of Wisconsin along that same line, which may be of interest to you. This is the beginning of a plan by which it is hoped to establish a reservoir system which will be practically under the control of the State, as it will be controlled and known as the Wisconsin Water Reservoir Commission.

Three members are State officers, one member is appointed by the Government, and the other is chosen by the interests that are endeavoring to establish this reservoir system. There is no provision under the laws of the State for creating any reservoir system, and it must be done by private enterprise. It has been carried on in a limited way on some of the streams, but in order to avoid friction, it is proposed to make a general change so that there shall be a uniform method of handling the storage in the hope of decreasing the liabilities of fire and increasing the advantages of re-foresting.

Yours respectfully,

L. M. Alexander.

Port Edwards, Wis.

[Enclosed with this communication from Mr. Alexander, who is president of the John Edwards Mfg. Co., was a copy of a bill marked "Substitute for No. 240 S," of which the leading provisions are the following:

Subject to supervision and control provided for, the bill gives authority to the Wisconsin Valley Improvement Co. to create, acquire and operate a system of water reservoirs along the Wisconsin River and along its tributaries, within designated bounds. For that purpose the bill authorizes the company to construct, acquire and maintain all such dams and other structures as may be necessary to accomplish the purposes of the bill, and it may improve the navigation of the streams.

This authority is granted for the purpose of producing as nearly uniform flow of water as practicable in the Wisconsin and Tomahawk Rivers through all seasons, by holding back in the reservoirs the surplus water in times of great supply, and discharging it in times of drought, and by other means improving the navigation of the rivers throughout their entire length.

For the purpose of creating, acquiring and operating the dams and other works, the Wisconsin Valley Improvement Co. is given powers of eminent domain.

In case the company shall improve any of the streams covered by the bill or shall acquire the control of the improvements of any river improvement company and shall so operate the works as to render the driving of logs and other floatables reasonably practicable and certain, it may charge reasonable tolls upon all such logs and other floatables driven on said stream.

When the company shall have in successful operation water reservoirs of a capacity sufficient to store in times of abundance and retain and discharge in times of scarcity 2,000,000,000 cu. ft. of water that would not be so stored up and retained by nature, it shall be entitled to charge reasonable uniform tolls from the owners or lessees of every improved and operated water power located below any of the reservoirs and benefitted by them. These tolls must exceed, however, a sum sufficient to pay all reasonable costs of operation and maintenance and a net annual return of 6 per cent. on the cash capital actually paid in on stock subscriptions to the grantee. The tolls shall be fixed in proportion to the benefits conferred by the reservoir system upon each of the improved and operated water powers.

The bill further authorizes a board of five members to be known as the Wisconsin Water Reservoir Commission. The director of the State Geological Survey, the State Forester, the Attorney General, and the president of the Wisconsin Valley Improvement Co. or its successor, shall each ex-officio be a member. The Governor shall appoint the fifth member. The members of this commission shall receive no compensation for services as such, but their actual expenses incurred in the performance of their duties, including any incurred for the services of engineers or other persons necessarily employed by them, shall be paid by the Improvement Co. No dam or reservoir not now in existence or heretofore authorized shall be constructed or created until the plan therefor showing the form and location of the dam and a description of the lands to be overflowed thereby be first approved by the commission. The commission shall cause the height to which the water may be raised by any dam to be marked by permanent monuments and bench marks. They shall have authority to employ hydraulic engineers and other persons to assist them in obtaining the information necessary to a proper discharge of their duties. They shall have supervision and control of the times and extent of the drawing of water from the reservoirs, and all data upon which the fixing of any tolls shall be contemplated shall be submitted to the commission and the proposed levy of tolls must be approved by them before the tolls shall be collectable.

The State shall have the right at any time, whenever it may have the constitutional power, to take over all reservoirs and other works and property acquired by the Wisconsin Valley Improvement Co., by paying therefor the fair value of the physical properties so taken over and without any allowance for franchises or good will of the business. If such fair value cannot be agreed upon between the State and such owner, it shall be determined by three appraisers, one appointed by the Governor, one by the owner of the property, and the two first appointed shall choose a third. The decision in writing of a majority shall be final.]